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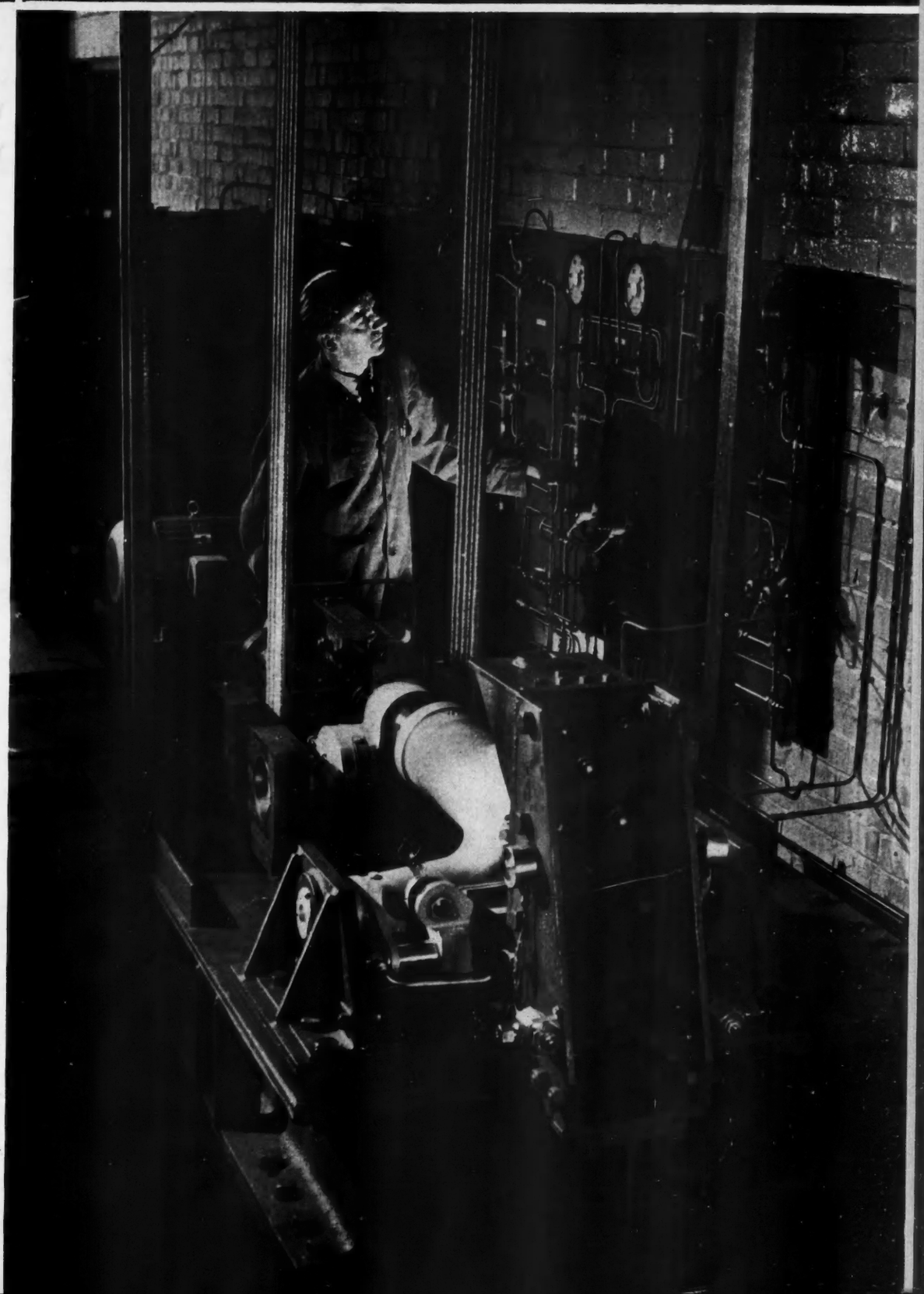

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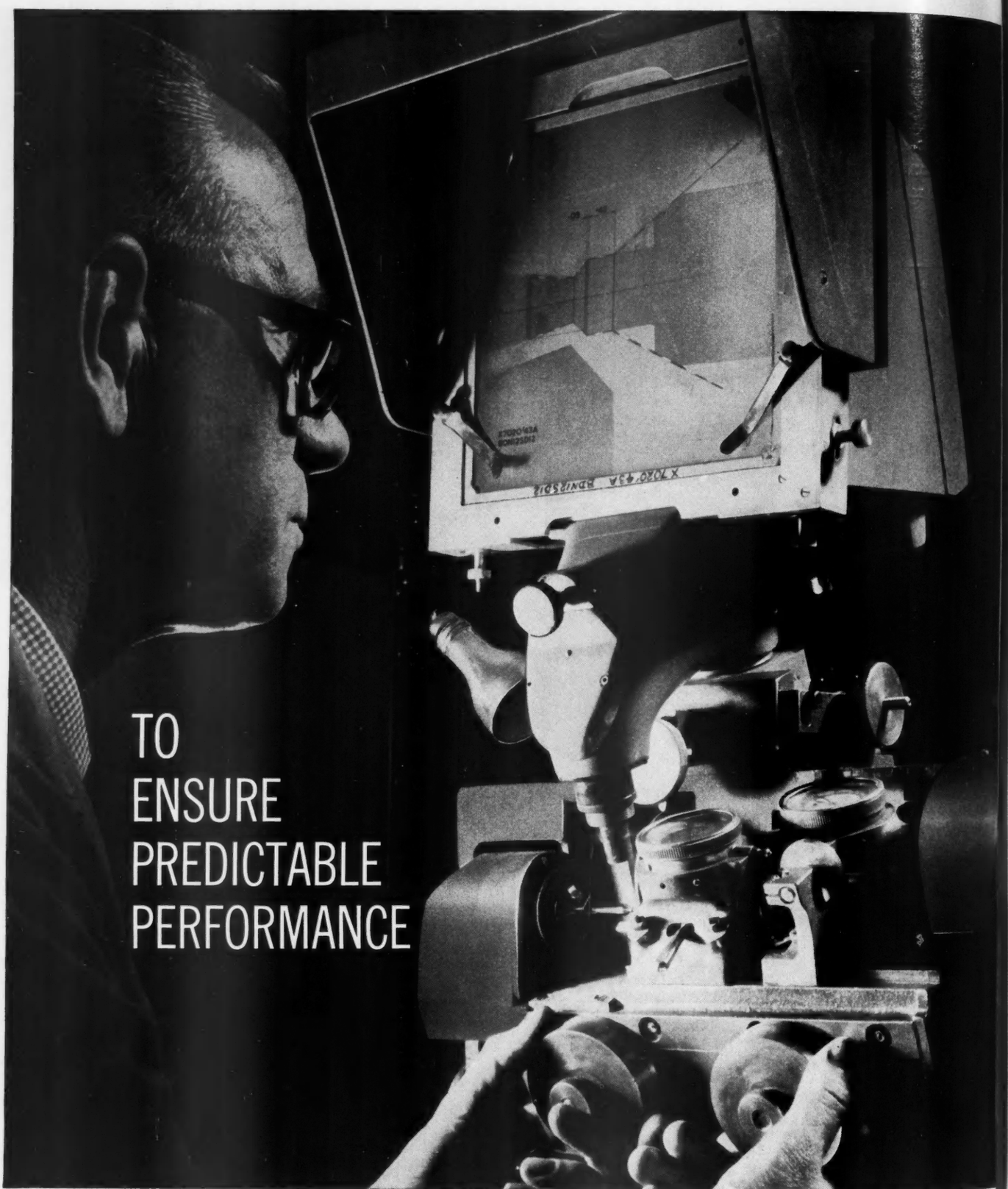

C.A.V.

AP 162

Extremely small variations in fuel injector nozzle manufacture can seriously affect combustion efficiency. Very special precision production methods are called for. As an instance, in the grinding of C.A.V. pintle nozzle needles, the work is controlled by comparing the greatly enlarged image of the needle with a master on a screen before the operator, so that uniformity of form and dimensions is maintained to exceptionally close limits.

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24 March 1961

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Applying loads to an Argosy nose undercarriage through hydraulic jacks to simulate vertical drag and side forces. The control system is in the background. (*Nurnberg photograph for* ENGINEERING.)

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TENDERS

THE DIRECTOR GENERAL OF INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, invited **TENDERS** for the supply of:—

	QUANTITY
GALVANISED WIRE, 0.35 in. circ. and	Yards 58,085
WIRE RINGS of various sizes ...	Nos. 16,575

All to Admiralty Specification.

Forms of tender may be obtained from the above address on or after FRIDAY, the 24th MARCH, 1961, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on MONDAY, 24th APRIL, 1961.

Please quote Reference No. 46/60/RLY. F 201

LINCOLNSHIRE RIVER BOARD

BOYGRIFT PUMPING STATION

TENDERS are invited from PUMP MANUFACTURERS for supply, delivery and erection of THREE LAND DRAINAGE PUMPS and all ancillary equipment to be installed in a new pumping station near SUTTON-ON-SEA, LINCS.

The pumps shall be of the vertical spindle type, with syphon discharges and shall be coupled direct to electric motors. The total discharge capacity required is 123 cusecs against a static head of 13 ft. 0 in.

Contract Documents and Drawings may be obtained from the Engineer to the Lincolnshire River Board, 50 Wide Bargate, Boston, Lincs, on the payment of a deposit of £5 5s. 0d. which will be refunded on receipt of a bona fide tender, not subsequently withdrawn, and the return of the documents.

Tenders, enclosed in a plain sealed envelope, and endorsed "BOYGRIFT PUMPING STATION" must be delivered to the undersigned not later than noon on MONDAY, 1st MAY, 1961.

G. E. PHILLIPPO,
Clerk of the Board.

50 WIDE BARGATE,
BOSTON, LINCS.
March, 1961. F 179

URBAN DISTRICT COUNCIL OF BRAINTREE AND BOCKING

CODHAM MILL WATER SCHEME

CONTRACT NO 9—

PANFIELD LANE WORKS

The Council will shortly be inviting Tenders from selected Contractors for the construction of a 3 million gallon reinforced concrete reservoir, retaining walls, high class brick booster station, concrete roadway, water pipe and drain laying, and ancillary works at their Panfield Lane Site.

Only Contractors who are fully experienced in this class of work will be considered; sub-contracting of the brick buildings will be permitted providing the nominated Firm is thoroughly experienced and approved.

Contractors who are desirous of being considered for the selected list should apply in writing, in the first instance, to the COUNCIL'S CONSULTING ENGINEERS, MESSRS. HERBERT LAPWORTH, PARTNERS, 25, VICTORIA STREET, WESTMINSTER, S.W.1.

The Council does not bind itself to accept the lowest or any Tender.

W. BALSON,
CLERK OF THE COUNCIL.

TOWN HALL,
BRAINTREE. F 91

ENGINEERING Impact

of a New York World Trade Centre

To the Governors of New York and New Jersey, the bi-state port commonly known round the world as New York has recommended a plan for a world trade centre which should be thoughtfully considered in the United Kingdom.

At the immense cost of $355 million (£126 million) the Port Commissioners would like to construct a trade centre, including a 72 storey world trade market, an eight storey securities exchange, and a 30 storey commercial exchange, all served by a concourse on a variety of levels. With natural enthusiasm for their project the Port Commissioners say that the centre would have unique advantages in its accessibility and in being beside "the traditional core of world trade activity in Lower Manhattan."

Listing the advantages such a centre would give to the port, the commissioners say it would stimulate the entry of United States manufacturers into foreign trade through the port. On the assumption that federal urban renewal assistance would be forthcoming, the commissioners believe that if, as planned, construction starts next year the centre would be complete in 1968.

As a show place, and as a great assistance in centralising all the complex agencies and authorities involved in foreign trade transactions, such a world centre would have obvious influence. It would be a facility, very possibly a trade creating one by the simple action of making the process easier, which London is not equipped with now, nor is likely to be by 1968.

Sterling is still one of the great trading currencies of the world and London still the major port for British imports and exports and much else besides. One of London's particular shortcomings from the point of view of the industrialist is its lack of an adequate permanent industrial exhibition building.

The combination of grand scale trade centre, with the bringing together in one building of representatives of the services of negotiation, finance, transport and all the involved elements of international trade would usefully reassert the trading position of London as a world centre. Located east of the City it could also bring new life to a very tired looking part of London.

Oil in India's Industrial Future

As the largest of the nations not clearly committed to either of the great power blocks, India is closely watched for any move suggesting a change in her future course.

This is at least part of the explanation of the close interest maintained in the developments in India's importation and use of oil. For some time negotiations have been underway over the refining of crude oil produced in India.

The Minister of Mines and Oil, Mr. K. D. Malaviya, recently declared in the Indian Parliament that these negotiations were not going on in satisfactory fashion. The general managers of Standard Vacuum and Burmah Shell in a joint statement then denied responsibility for delays in the talks.

While this has been going on, the Indian Oil Company has been completing its plans to import 1,500,000 metric tons of petroleum products from the Soviet Union over the next four years.

It seems likely that eventually Western owned refineries at Bombay will refine quantities of Indian produced crude. From a statement of the Mines Minister it appears that one point on which agreement is not complete is whether the refineries should be enlarged to cope with Indian crude or whether the Indian product should replace imported crude oil.

India has put Western and Soviet aid to use in her successive five-year plans. In an Asia which is otherwise dominated by a resurgent China her importance to the West is hard to exaggerate. It is to be hoped that Indian industrial expansion will receive nothing but vigorous support from those sectors of Western industry that become involved. The Indian problems are on the grand scale, but there is more than one helper.

British Shipping Losing to Competition

The success of competing foreign shipping operators is sharply underlined by the melancholy revelation that for the first time in the records of United Kingdom shipping more than half of Britain's overseas trade was carried in foreign ships.

The Liverpool Steam Ship Owners' Association in its annual report records that the proportion of British overseas trade carried in our own vessels has declined as follows: 1938—57 per cent, 1956—54 per cent, 1959—51 per cent, and last year—49 per cent.

It may be that the position is going to be held this year, for our best effort came in exports, where British vessels carried 60 per cent of the cargoes, and it is here that vigorous efforts at increasing the volume to be carried are being made. A much lower percentage of the import trade was brought in under the Red Duster, and the February trade returns suggest that the long awaited drop in imports may at last have materialised.

The greater increase on the import side reflects the drive among a number of overseas nations to run their own shipping lines, and to legislate in such a way as to guarantee cargoes for their ships. With preferential policies so widely practised some worsening of the position was to be expected in a year when the volume of imports rose to the record level of 128 million tons, an increase of 14·5 per cent on 1959. Exports reached a total of 26 million tons, 600,000 tons above the 1959 figure.

This is not a situation in which shipping operators are likely to confine themselves to observations on the practices of overseas states. Winning back lost trade will require improvements in services, re-examination of charges, and above all the serious consideration of a policy of scrap-and-build, which would bring joy to the shipyards and could also bring cargoes back to the holds of the British merchant marine.

of Taking the Brake off the Commonwealth

For the Commonwealth the biggest problems lie ahead, and not at any great distance.

Starting with India or Nigeria, Pakistan or Ghana, a long list can be compiled of the Commonwealth members whose lands are only now emerging from the underdeveloped phase. All of these countries need aid on a grand scale; just as much though, there is another need which is a less convenient one to acknowledge — the need to trade. The new light industries of the emerging nations must export their products. Professor Cairncross, the Government economic adviser, has pointed out how international agreement on this problem could lessen the impact on any one nation.

In Commonwealth terms the purchasing power of the richest members, of the United Kingdom, of Australia and New Zealand, and of Canada, could give a major impetus to new industries on the west coast of Africa and elsewhere. The incidental effect of speeding up the demand for capital equipment would be a direct advantage to the electrical and the steel sectors of the engineering industries.

There is room too in the Commonwealth for a surge forward in the sharing of technical training resources. A great deal is being done at the university level and the paradox of pouring out lawyers and economists fo hungry, poverty ridden territories has become less so as the number of engineers, agricultural specialists and so on has risen. But how many Commonwealth students are there in the technical schools?

Certainly skilled technicians are short in the United Kingdom. In Pakistan and many parts of Africa, though, they are almost non-existent.

In time a party may come to power in South Africa believing in the Commonwealth ideals and, on the material side, in the fact that the surest way to increase prosperity is to educate and enrich the whole of a nation's population. Imaginative cooperation with a new level of vigour and effectiveness can by then have raised the Commonwealth to a position where South Africa may be keen to apply for readmission.

Guillebaud and the Jobs at the Top

It is an intriguing speculation to wonder what happened in the collective mind of the Government between last June when the decision to appoint Mr. Alfred Robens, a Labour parliamentarian, to lead the National Coal Board was taken, and this month, when one of the outstandingly successful careers in large scale business administration was diverted, temporarily, to bring Dr. Richard Beeching from the Imperial Chemical Industries' boardroom to the chairmanship of the new Railways Board, without the loss of salary associated with moving from private business to the public service.

There are two courses for the direction of the nationalised industries which may have been set by the Government and it may be some time before it is clear which is currently in fashion.

Dr. Beeching, whose salary so far overshadows that of the departing Sir Brian Robertson or any other chief of a nationalised industry (surtax calculations will carry little weight in the inevitable arguments of local union branches), will be tackling what he has termed the "very, very difficult management problem" of the railways for the next five years. After that, the leadership of the railways will pass into the hands of another administrator who has proved himself in the competitive world of large scale business, or back to a retiring diplomat, politician or similarly administratively unproven appointee. On the face of it, the second proposition is close to unthinkable.

If the Beeching appointment signifies the end of an era for the leadership of the nationalised industries it may also signify the beginning of a new deal for their higher administrators: in more generously spaced steps on the reward scales, in knowledge at the top of what can be achieved with modern management methods, and not least in directness of responsibility for results.

That Dr. Beeching is not a railwayman is no less irrelevant than that Mr. Khrushchev is not a physicist. The Soviet Union's space programme is no less successful for that. And ICI's chairman, Mr. Paul Chambers, made his name outside the profitable fields of that successful organisation.

A New Town in the North West

The Government's announcement of a new town in the North West, to house about 80,000 people from Merseyside at Skelmersdale, between Wigan and Ormskirk, is welcome to industry for more than one reason.

Space for industrial expansion within established Merseyside is as difficult as in the Midland centres or London. Suitable industry, the Ministry of Housing and Local Government has said, will be encouraged to move to Skelmersdale.

For the construction industry there will be the fresh opportunity offered by the need to provide homes for the great majority of the 80,000 and to put up the new shops, schools and other social facilities of the new town.

Merseyside has a major problem in the replacement and renewal of old, outworn property, along with most industrial centres. This partly accounts for the pressure on accommodation in the area. The new town will assist in easing this situation, at the same time as giving to its people the framework of a life with new horizons.

In the event of objections to the plan a public local inquiry will be conducted. Mr. Henry Brooke, the Housing Minister, has signed a draft order designating the land following consultation with the local authorities. Eventually, if all goes well, a development corporation will be set up to prepare the comprehensive "master plan."

The North West region is not alone in having a first class case for a new town whether in the interests of its overcrowded people or of expanding industrial interests. It is to be hoped that Mr. Brooke's new step in Lancashire is one of a series.

Glass Strengthens Plastics Such as Nylon

Filling thermoplastics with glass fibres before moulding them can improve properties. An American firm who export to the UK have found a way of doing this.

THE concept of using one material to reinforce another has been used very successfully with thermosetting plastics like polyesters and epoxies. But with thermoplastics like nylon and polystyrene it has proved more difficult, although the incorporation of, say, glass fibres seems to be a way of increasing low temperature impact strength, preventing cold flow under stress, and bringing about many improvements in performance.

Fiberfil in the USA have been making a glass reinforced nylon for several years and up till a few months ago ICI acted as selling agents in the UK. Fiberfil have now extended their range to include several other grades of nylon and have apparently successfully reinforced polystyrene, an acrylonitrile (ABS plastic) and polycarbonate.

A comparison of properties can be made from the table and the bar graphs, and examples of uses of the materials are shown around this page. The following comments are those of Fiberfil.

Impact strength of all thermoplastics will drop with a decrease in temperature to a more or less alarming degree. This is true of both plain polystyrene and nylon. However, with the glass filled varieties, the Izod impact strength increases. Some other properties also stand out—for instance, tensile strength and deformation under load. The grade of glass filled nylon called Nylafil G1 has almost twice the strength of unreinforced nylon, while the new series of Nylafils, G10 and G13 are almost three times as strong. In fact, these latter grades are reaching well into the tensile levels of commonly used metals.

Unfilled thermoplastics have long been plagued by dimensional instability in demanding mechanical applications. Such characteristics as moisture susceptibility and resulting dimensional change, coefficient of linear thermal expansion, and residual release of strains have eliminated mechanical type thermoplastics from many applications where they were otherwise ideal.

Glass reinforcement reduces the coefficient of linear thermal expansion from one-fifth to one-seventh of previous levels. In those materials which are moisture sensitive the reinforcement makes a proportionate improvement. These materials are also much more stabilised against residual stress release.

	Unfilled Nylon 66	Nylafil G1	Nylafil G10	Unfilled ABS	Acrylafil G40	Acrylafil G41	Unfilled Polycarb.	Carbafil G50
Tensile strength at 73° F, lb per sq. in	11,800	19,100	30,000	11,000	20,000	15,000	9,000	19,000
Elongation at 73° F, per cent	60	1·5	1·9	3·2	1·0	1·0	60–100	1·4–2·0
Impact strength, Izod, at 73° F ft-lb per sq. in, at − 40° F	0·9	2·5	3·3	0·45	3·5	5·5	2·8–2·0	2·0–2·5
	0·6	3·0	4·0	—	4·0	6·0	—	—
Flexural strength, lb per sq. in	11,500	22,000	37,000	17,000	28,000	27,000	12,000	26,000
Rockwell hardness	M79	M100	E75	M83	E68	E62	M70	M95
Deformation under load, at 4,000 lb per sq. in, per cent	2·5	0·6	0·4	—	0·3	0·4	0·3	0·1
Water absorption, 24 hr, per cent	1·5	0·7	0·6	0·2	0·2	0·15	0·3	0·08–0·10
Specific gravity	1·14	1·36	1·52	1·07	1·35	1·37	1·2	1·4–1·52
Heat distortion temperature, at 264 lb per sq. in, ° F	150	498	502	200	220	215	280	300

(Above) Comparison of Properties.

As far as the chemical and electrical characteristics of the compounds are concerned, they are quite similar to the unreinforced base plastics. As an example, nylon maintains its lubricity, while polycarbonate is still non-flammable.

Standard Nylafils are the G1, G2 and G3 grades which are based on type 66, type 610 and type 6 nylons, respectively. In addition, a number of special compounds are offered for specific applications or environmental conditions. Among these are G1 (EM) which is an easier moulding and better filling grade. G1 (HR) is a hydrolysis resistant grade, particularly adaptable to hot water applications which have shown no significant degradation after three months in 180° F water. Where increased lubricity is required, in such applications as cams and bearings, G1 (MS) containing 5 per cent molybdenum disulphide has been found to be very advantageous. When high environmental temperatures are involved, G1 (HS), a heat stabilised grade, is recommended. This material has been tested at 400° F for 100 hours and has shown only a loss of 10 per cent of its original physical properties.

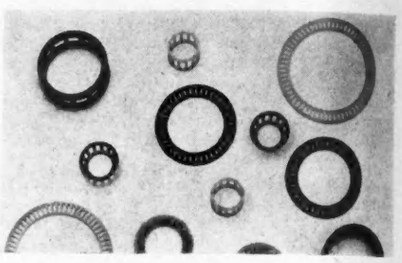
Most recently introduced were the new G10, G12, and G13 series of Nylafils. These materials are the highest strength thermoplastics on the market and are only exceeded mechanically by one or two thermosetting moulding compounds.

Nylafils have been applied in such parts as gears, bearings, coil forms, bearing retainers and similar mechanical components.

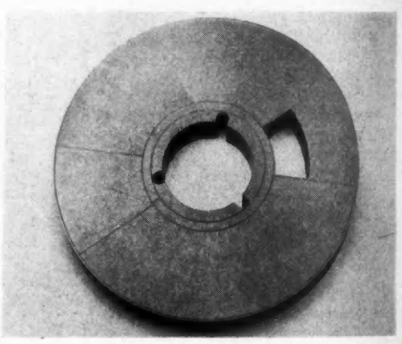
Polystyrene is not generally considered to be a material suited for mechanical applications, but addition of glass fibre gives it vastly improved mechanical properties and better dimensional stability. Three applications of these Styrafils are shown around the page.

Two grades of reinforced acrylonitrile (ABS plastic) were recently introduced which show very promising characteristics. Called Acrylafils, they have high mechanical properties, plus good solvent resistance.

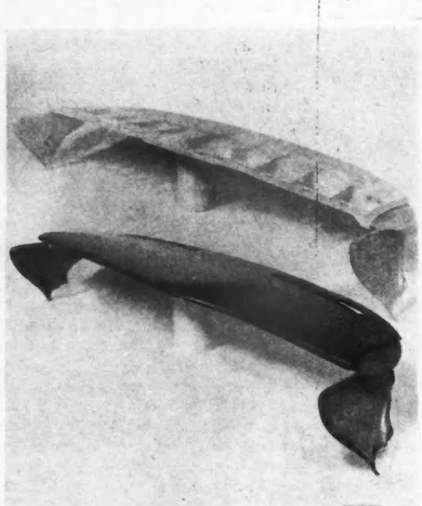
Continued on next page



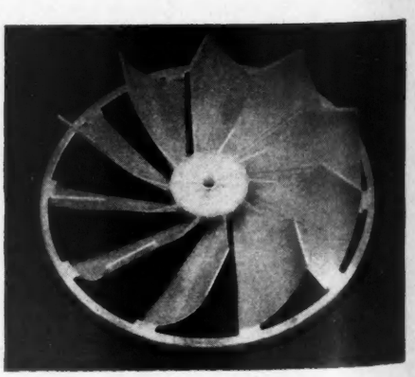
***Bearing Cages.**—These have been made in glass filled nylon. Fiberfil say that plain nylon has been generally eliminated from such uses because of its high coefficient of thermal expansion. Glass restricts expansion to about one-fifth the value, improves toughness, yet retains lubricity.*



***Tape Reels.**—These were originally made in polystyrene. But as designs became larger and service temperatures in the electronic equipment became hotter, so the first grades tended to lose their stiffness. In addition, the hubs cold flowed and permitted them to lock on the tape deck spindles. These are now made in the glass filled variety of polystyrene and are coloured by incorporating pigments. Fiberfil say the moulding is uniform and colour dispersion is good.*

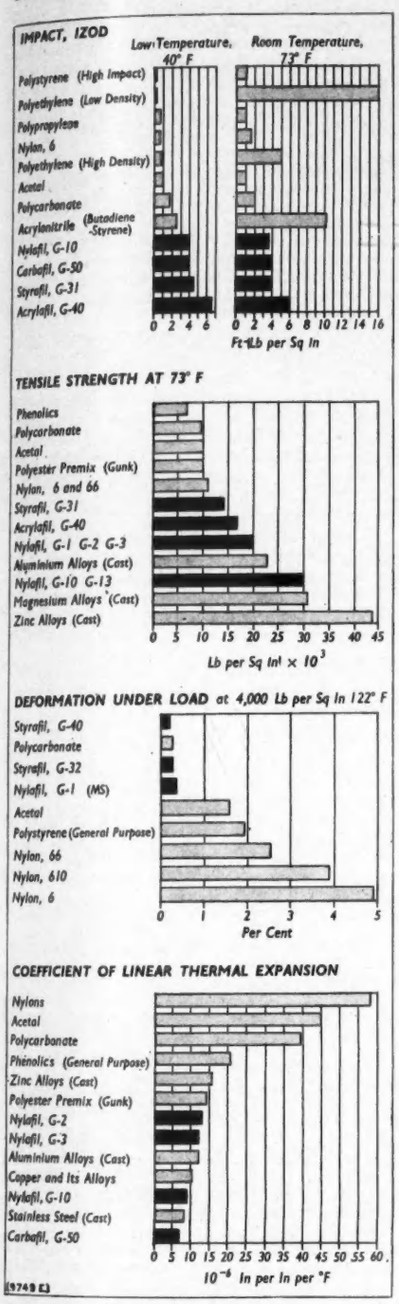


***Crash Pad in Car.**—At the top is an injection moulding in glass filled polystyrene weighing 43 ounces and being 54 in wide. Fiberfil say this is for one of the major car makers in the USA and is the largest-ever car injection moulding. It is moulded on a 175 oz machine in a 11,000 lb tool. The cavity is fed by 5 hot runners spaced along the length of the part. Note, they say, the good flow around cores. Filled polystyrene was chosen because of its stiffness and dimensional stability and it is said to cost less than metal stampings it replaced. To complete the pad, which goes above the facia panel, urethane is foamed in place and a hot vinyl cover stretched over it.*



***Blower Wheel.**—When made from aluminium, this wheel set up a resonant hum in an air conditioning unit. Now made in glass filled polystyrene, the wheel is described by Fiberfil as rigid. Should ice form in the unit during the winter and the blower be switched on, the bades will withstand the impact stresses at these low temperatures.*

Continuing Strengthened Plastics



Also recently introduced is the new G50 glass fibre reinforced polycarbonate, called Carbafil. This is also the first Fiberfil material which will meet the Underwriters' flammability test. The Carbafils have good mechanical properties and very low moisture absorption.

All the materials are normally supplied in a pellet form for moulding to the finished shape. It is recommended that turning and machining should be avoided as this cuts through the glass filaments, and a quite wrong impression could be obtained through machining a prototype from solid where it will be subsequently moulded.

[The attractiveness of these materials is recognised, but their usefulness will depend very much on cost. In the UK, the first Nylafil grade proved rather expensive in at least one firm's experience. Readers desiring more information should write to Fiberfil Inc., Warsaw, Indiana, USA. ENGINEERING hope to be able to put readers on to UK suppliers of such materials. Write to the Metals and Materials Editor at 36 Bedford Street, London, WC2.]

Fire Protection for Aluminium Ships

Turners Asbestos Cement Company have had tests carried out by the Fire Research Station to form a basis for calculating suitable insulation thicknesses for protection of aluminium superstructures in ships. Initial calculations performed before the main test with the aid of the Station and with the Aluminium Development Association have apparently been successful.

The test was carried out on a square flat structure made up like a deckhead measuring 10 ft by 10 ft and being about 6 ft high complete with protected beams. Insulation was provided on three sides of the structural sections by Turnall asbestos ships board. Three thicknesses of this material were actually tested, say the company, and in order to comply with the Ministry of Transport regulations it was necessary that a rise in temperature in the aluminium did not exceed 200° C. The ¾ in thick material provided excellent insulation in that, at the end of 60 minutes, the temperature did not exceed 154° C.

The deck plate itself was protected partly with ¾ in Turnall asbestos ships board and partly with ⅜ in perforated Turnall asbestos ships board ceiling panels backed with 1 in of Fibreglass. During the test, which lasted just over 60 minutes, at no time did the surface temperature on the unexposed face exceed 124° C rise, which is some 15° C below the maximum permitted temperature rise of 139° C.

The company forecast that these successful tests will eventually lead to shipbuilders being able to use aluminium deck members in their vessels instead of mild steel.

Turners Asbestos Cement Company Limited, Trafford Park, Manchester 17.

Standards for Aircraft Aluminium

Aluminium and aluminium alloys which pass the searching inspection and tests laid down in the new edition of British Standards L100 " Inspection and Testing Procedure for Aluminium and Aluminium Alloys " should meet the latest requirements of aircraft manufacturers.

This British Standard—which now bears the reference 2L100 instead of L100—was first published in 1951. Amendments made in 1953 and 1955 are incorporated in the new edition, with changes agreed between manufacturers and users in the light of experience gained with the old edition.

The principal changes are these: new tolerances are specified for the various forms of product covered by the standard; metric equivalents and tolerances are introduced, with requirements for their use; requirements for controlled stretching of bars and extruded sections are also introduced; and the head forming test for rivets is replaced by a torsion test.

Revision of this important standard means that the numerous related British Standards for aluminium alloys have also had to be brought up to date. Revision of these is still proceeding but 22 new and revised standards, some of which replace specifications in the Ministry of Aviation DTD series, have just been published.

British Standards Institution, Sales Branch, 2 Park Street, London, W1. 2L100 is 25s, the rest 2s 6d each, postage extra to non-subscribers.

Adhesive for Flexible and Rigid Foams

Evo-Stik impact adhesive 633, which consists of a one-part rubber/resin formulation, has been developed by Evode. It is said to provide a strong resilient bond when joining polyurethane or polyether foam to materials such as fabric, wood and metal without affecting the microcellular structure of the foams.

When used for joining foam to itself the resultant joint is flexible, which is a useful property when used in the upholstery industry with soft padding materials.

This adhesive is water and oil-proof and is resistant to high temperatures. One gallon is sufficient to bond about 15 square yards of foam allowing for coating both surfaces. It is recommended that all surfaces to be joined should be thoroughly clean; for example, metal should be degreased with trichloroethylene, and dust and other foreign matter removed from the foam.

Ten to thirty minutes after application of the adhesive, the two surfaces can be pressed together by hand. They will bond immediately so that joined components can proceed unhindered in the course of production. If the adhesive is to be applied by spray gun or roller coater, it is recommended that three parts of the adhesive should be mixed with two parts of Evo-Stik cleaner 191 before use. Evo-Stik 633/S is a version which is ready-diluted for this purpose. The same cleaner solution can be used to remove surplus adhesive and to clean brushes and tools.

Evode Limited, 92 Victoria Street, London, SW1.

Unusual Steel Looks Promising

Inco have just announced that a new family of steels could result from research work they have been performing at Bayonne, New Jersey. So far this has led to one particularly successful alloy with a composition of 18Ni-7Co-5Mo-steel with less than 0·5 per cent titanium and 0·05 per cent carbon.

It is the only known material, say Inco, which has a yield strength in excess of 250,000 lb per sq. in while maintaining a nil ductility temperature below — 80° F. Notched tensile strength has exceeded 400,00 0lb per sq. in with a notch radius of 0·0005 in. There are indications, add Inco, that high strength levels of up to 500,000 lb per sq. in or even higher may be obtained with this type of steel. A 10 ton commercial heat has been produced in America by air melting in an arc furnace, presumably to the above composition, and ingots as large as 23 in by 42 in from this heat have been rolled into plate on conventional steel mill equipment.

The original American release says that the steel develops its high strength by means of a remarkably easy heat treatment involving age-hardening of martensite. For this they have invented a term " mar-aging." With proper finishing temperature off the mill, followed by air cooling to room temperatures, the treatment consists of holding for about three hours at 900° F and air cooling. Solution annealing at 1,500° F prior to mar-aging is optional. Quenching is not required, say Inco, and full properties can be developed in heavy sections with no distortion problems.

Certainly, in adding 7 per cent of cobalt to a nickel-steel, Inco are breaking new ground, and the strength figures as now released are worth noting. It will seem a pity to some people, however, that what appears to be a quite normal heat treatment should be clothed in a fancy name. On present evidence, and Inco (Mond) in the United Kingdom say they are awaiting fuller information, this appears to be a composition with good hardenability which turns to a partly martensitic structure on air cooling. This can be tempered, possibly to bring out titanium carbides, in a quite normal tempering treatment.

Inco add that they have obtained sound crack-free welds even on material in the fully heat treated condition without preheating. They also claim that a straight tempering treatment after welding will restore strength to the heat-affected zone as well as in the weld metal. Low work-hardening rates permit extensive cold forming. The machining characteristics are described as excellent both as rolled and even as fully hardened.

International Nickel Company (Mond) Limited, Thames House, Millbank, London, SW1.

Plain Words

By Capricorn

THIS outcry against paying a public servant his market value brings me back to what has lately been a favourite topic of mine—salaries and wages. No one, I have heard it said, can be worth such an enormous figure as £24,000 a year—not even Dr. Beeching. I must confess that I was equally disturbed. I don't think they're paying him enough.

We do not place a value on a man—a man may be worthless or more precious than rubies, according to your point of view. We place a value on the job. If the man can do it, we are contented. If not, we get another man.

Surely we can afford to pay a man, say, 5 per cent of the total revenue he is capable of earning? And Dr. Beeching's job of running British Railways could net much more than twenty times his salary. Admittedly, he hasn't proved himself as yet, but by offering a figure commensurate with those arrived at by the testing processes of industry we stand a better chance of getting someone capable of handling so difficult and critical a task.

As his employers, what shall we in fact be paying him? It has been widely pointed out that after tax he will only receive some £6,500. But whereas a private company would have to foot a vastly greater bill to give him this net income, it only costs the Government (being both employer and tax collector) the actual figure that it pays him. It is surprising that the Government (on our behalf) should be so parsimonious when recruiting staff, since £6,500 a year expended by the Government competes with £24,000 offered by a private company. And think what first-class executives might save the nation.

Look at it this way. A man who works independently may have an idea that saves him an hour's work a day, or five hours a week. Another man who supervises ten men may introduce a change that saves each of them an hour's work a day or fifty hours a week. His influence and value to his company is thus multiplied by the number of men directly under him. Similarly, a small saving in the material used to build a motor car may mean a fortune at 100,000 cars a year.

Thus, a man controlling the staff and resources of a vast public corporation has a tremendous potential for saving or making money. A single idea might well be worth £1 million.

It prompts me to propose—though not too seriously—a sort of pyramid wage structure, with each man being paid the sum of the wages paid to his immediate subordinates. Thus it would work out that the man at the top would receive a salary equal to the combined wages of all those forming the base layer of the pyramid. It would be necessary to pay each man in addition something for the capital resources he controlled.

Come to think of it, as a journalist I wouldn't do too well: I manage neither people nor resources. Perhaps it isn't such a good suggestion as I thought.

Letters to the Editor

Bring on the Singing Girls

SIR, May I refer to your humorous Impact note regarding the warblings of Italian brickworkers in Bedford (" O Sole Mio and a Shortage of Bricks," ENGNG., 9 Dec. '60, p. 777)?

The scene was a Royal Naval cordite factory during the 1914-18 war. The work girls—sisters, sweethearts, wives, daughters of the soldiers and sailors for whom they were pressing hundreds of tons of cordite—were singing happily at their work; for which they were paid 6*d* per hour, with ½*d* per hour extra danger money. A party of brass hats was being conducted round by a select coterie of directors. The girls sang on. The following day a notice was received from the management forbidding singing by the girls in the press rooms. As superintendent on that range I received the notice, read it, screwed it up and dropped it in the wastepaper basket; and my girls sang on. My opposite number on the other shift—being perhaps a more law-abiding fellow than myself—obediently imposed the singing ban on his girls.

The book in which was recorded the shift work tally, recorded that, dating from the imposing of the singing ban, the output of the silent canaries fell by something like 10 per cent, while the persistent warblers continued to produce 15 per cent above the planned rated output of the plant.

Two or three weeks later I received word from the management—" it was noted that in spite of orders to the contrary, the workers on cordite range X still continued to sing at their work."

I interviewed the source of that memo—accompanied by the appropriate shift work tally—and pointed out the effect that the singing ban had on output. The ban was lifted immediately and output was restored.

This is a perfectly true story and the moral is not far to seek!

Those girls had not a lot to be happy about. The explosives works were situated in an isolated area of the Thames marshes. The girls were fetched to their work from 18 to 20 miles away in hooded lorries. They were signed on 12 hours per day for six days per week, and in many cases, were away from home 15 hours out of the 24, six days a week, working with guncotton or nitroglycerine for the princely wage of 6*d* per hour and ½*d* danger money. No, they hadn't a lot to be happy about, except that they were working for " their men." As you heard them going through the village, singing in their lorries " Long, Long Trail " " Keep the Home Fires Burning," " When You Come Home Dear," " Pack Up Your Troubles," and all the songs of the time, you didn't hear many grumbles about the row they kicked up. One marvelled at their spirit. I did; I worked with them—even though I was a " boss."

Let the people sing!

Yours faithfully,
ARTHUR A. GLOSSOP.

Sheffield, 6.
14 March, 1961.

Events in Advance

Handling for Profit

FOLLOWING upon the success which attended their conference last year, the Willesden and Hendon Local Productivity Association have arranged another.

It will be a one-day event on materials handling. The organisers stress the fact that every time a product is handled in any way, something is added to its cost without increasing its value, and they have accordingly chosen " Handling with Profit " as the special theme of the conference. In addition to talks and discussions, there will be two short films.

The meeting, for which an attendance fee of three guineas is being charged, will be held at the Willesden Technical College, Denzil Road, London, NW10, on 12 April. Applications should be sent to Mr. G. R. Lutner, S. Smith and Sons (England) Limited, Waterloo Road, London, NW2. Tel. GLAdstone 6464.

Prince Philip to Hear About Interior Lighting

ARRANGEMENTS have been made by the Illuminating Engineering Society for their new code of practice " Recommendations for Good Interior Lighting " to be discussed at a meeting on Tuesday, 11 April. It will take place at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2, and will commence punctually at 5.30 p.m.

The Duke of Edinburgh has chosen this occasion to attend his first meeting of the Society as an honorary fellow. He will hear Dr. W. E. Harper, chairman of the Society's code committee, deliver a lecture on the purpose of the code and its applications in industrial, commercial and domestic lighting.

Tickets are required for this meeting, and these and further information may be obtained from the secretary of the IES, Mr. G. F. Cole, 32 Victoria Street, London, SW1, or by telephoning ABBey 5215.

Exhibitions and Conferences

Zagreb International Autumn Fair.—Sat., 9 Sept., to Sun., 24 Sept., at Zagreb. Agents in the United Kingdom: Empson and Turner Group Ltd., Thorn House, Upper St. Martin's Lane, London, WC2. Tel. TEMple Bar 9081.

Brno International Trade Fair.—Sun., 10 Sept., to Sun., 24 Sept., in Brno, Jugoslavia. Agents in the United Kingsom: Fairs and Exhibitions Ltd., 2 Dunraven Street, Mayfair, London, W1. Tel. HYDe Park 5421.

Bolzano International Samples Fair.—Fri., 15 Sept., to Mon., 25 Sept., in Bolzano. Organised by the Fiera Campionaria Internazionale di Bolzano, C.P. 297, Bolzano.

Export and Samples Fair, 29th.—Sat., 23 Sept., to Sun., 1 Oct., at Innsbruck, Austria. In the United Kingdom, applications should be made to the Office of the Austrian Foreign Trade Representative, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Metz International Trade Fair.—Wed., 27 Sept., to Sun., 8 Oct., at Metz. Agents: Auger and Turner Group Ltd., Thorn House, Upper St. Martin's Lane, London, WC2. Tel. TEMple Bar 9081.

Purchasing Officers' Association " Minibition," 1961.—Thurs., 28 Sept., to Sat., 30 Sept., in Brighton. Organised by the Purchasing Officers' Association, Wardrobe Court, 146A Queen Victoria Street, London, EC4. Tel. CITy 3841.

Graz International Autumn Fair.—Sat., 30 Sept., to Sun, 8 Oct., at Graz, Austria. In the United Kingdom, applications should be made to the Office of the Austrian Foreign Trade Representative, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Welding in Shipbuilding, Joint Symposium on.—In October/November, in London. Sponsored by the Royal Institution of Naval Architects, the Institute of Welding, the North East Coast Institution of Engineers and Shipbuilders, and the Institution of Engineers and Shipbuilders in Scotland. Apply to the secretary of the organising committee, c/o the Institute of Welding, 54 Princes Gate, Exhibition Road, South Kensington, London, SW7. Tel. KNIghtsbridge 8556.

Modern Jewellery, First Major International Exhibition.—In October and November at the Goldsmiths' Hall, Foster Lane, London, EC2. The general theme will be the evolution of 20th century jewellery design. Organised in association with the Victoria and Albert Museum. Apply to the Clerk, Worshipful Company of Goldsmiths, Foster Lane, London, EC2. Tel. MONarch 1668.

Shoes for Spring Exhibition.—Mon., 2 Oct., to Thurs., 5 Oct., at the Mount Royal Hotel, Marble Arch, London, W1. Exhibition includes the display of some shoe and leather machinery. Organised by the British Footwear Manufacturers' Federation,

22 Gilbert Street, London, W1. Tel. MAYfair 2843.

"Fashion in Footwear" Exhibition.—Mon., 2 Oct., to Fri., 6 Oct., at the Washington Hotel, Curzon Street, London, W1. Including the display of some leather and shoe machinery. Apply to the Exhibition Department, *Footwear*, Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Business Efficiency Exhibition, 49th.—Mon., 2 Oct., to Wed., 11 Oct., in the Grand Hall, Olympia, London, W14. Organised by the Office Appliance and Business Equipment Trade Association of Great Britain and Ireland, 64 Cannon Street, London, EC4. Tel. CENtral 7771.

Electronic Computer Exhibition, Second British.—Tues., 3 Oct., to Thurs., 12 Oct., at Olympia, London, W14; and the **Business Computer Symposium.**—Wed., 4 Oct., to Fri., 6 Oct., also at Olympia. Both events are being organised by the Electronic Engineering Association, 11 Green Street, London, W1 (Tel. MAYfair 7874); and the Office Appliance and Business Equipment Trades Association, 64 Cannon Street, London, EC4. Tel. CENtral 7771. (*Revised dates.*)

Canadian Institute of Radio Engineers, Fifth Convention and Exposition.—Wed., 4 Oct., to Fri., 6 Oct., at Exhibition Park, Toronto. Offices of the Institute: 1819 Yonge Street, Toronto 7, Ontario, Canada.

Motor and Motor Cycle Show, 48th International.—Thurs., 5 Oct., to Sun., 15 Oct., in Paris. Agent in the United Kingdom: R. C. Leibman, 178 Fleet Street, London, EC4. Tel. CITy 5889.

Knitting Machinery and Accessories Exhibition, International.—Wed., 11 Oct., to Sat., 21 Oct., at Belle Vue, Manchester. Organised by Textile Recorder (Machinery and Accessories) Exhibitions Ltd., Old Colony House, South King Street, Manchester 2. Tel. Deansgate 6903.

Mechanical Handling Exhibition, International.—Fri., 13 Oct., to Sun., 22 Oct., in Paris. Organised by the Salon de la Manutention, 40 Rue du Colisée, Paris 8.

German Industries Exhibition, Twelfth.—Sat., 14 Oct., to Sun., 29 Oct., in Berlin. Agent in the United Kingdom: Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Dairy Equipment Exhibition.—Wed., 8 Nov., to Tues., 14 Nov., in Paris. Organised by the Salon International de l'Equipment Laitier, 28 Rue Louis-le-Grand, Paris.

Medical Exhibition, 44th.—Mon., 13 Nov., to Fri., 17 Nov., at the Royal Horticultural Society's New Hall, Greycoat Street, London, SW1. Apply to the Exhibition Organiser, British and Colonial Druggist Ltd., 194-200 Bishopsgate, London, EC2. Tel. AVEnue 1444.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Instrumentation for Obstetrics," by Dr. C. N. Smyth. Medical Electronics Group. University College Medical School, Gower Street, WC1. Wed., 19 April, 6 p.m.

BIRMINGHAM
Annual General Meeting and Display of Technical Films. West Midlands Section. Electrical Engineering Department, The University, Birmingham. Wed., 19 April, 6.15 p.m.

BRISTOL
"Colour Television," by Dr. G. N. Patchett. South Western Section. School of Management Studies, Unity Street, Bristol. Wed., 19 April, 7 p.m.

NEWCASTLE UPON TYNE
"Colour Television," by Dr. G. N. Patchett. Annual General Meeting. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 12 April, 6 p.m.

Building Centre

LONDON
Film: "Ventilation, the Silent Fire Fighter," exhibited by Colt Ventilation Ltd. Wed., 19 April, 12.45 p.m.

Chemical Society

ST. ANDREWS
"Electron Configuration and Structure of Transition-Metal Complexes," by Professor R. S. Nyholm. St. Andrews and Dundee Branch. Chemistry Department, St. Salvators College, St. Andrews. Thurs., 20 April, 5.15 p.m.

Illuminating Engineering Society

LEEDS
"The Artistic Use of Lighting in Multi-Camera Technique," by H. E. H. Mayhew. Leeds Centre. Offices of the British Lighting Council, 24 Aire Street, Leeds 1. Mon., 17 April, 6.15 p.m.

LIVERPOOL
Annual General Meeting. Liverpool Centre. Electrical Industrial Development Centre, Merseyside and North Wales Electricity Board, Paradise Street, Liverpool 1. Tues., 18 April, 6 p.m.

Institute of Marine Engineers

LIVERPOOL
"Materials for Advanced Steam Conditions and Their Influence on the Operation of Marine Turbines and Boilers," by Commander H. E. C. Hims and S. H. Frederick. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. Mon., 10 April, 6 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
Annual General Meeting. Midlands Centre. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tues., 18 April, 7.30 p.m.

CARDIFF
Annual General Meeting. South Wales Centre. Grand Hotel, Cardiff. Fri., 7 April, 7.15 p.m.

HOVE
Annual General Meeting. Southern Centre. Palmeira Hotel, Hove. Wed., 12 April, 7.30 p.m.

MANCHESTER
Annual General Meeting. Manchester Centre. Engineers' Club, Albert Square, Manchester. Mon., 10 April, 7.30 p.m.

Institution of Agricultural Engineers

BRISTOL
"Hydraulics," by D. G. Booth. Western Branch. Offices of the South Western Electricity Board, Bristol. Mon., 17 April, 7 p.m.

Institution of Chemical Engineers

CHESTER
"Some Corrosion Problems in the Chemical Industry," by D. Bennion. North Western Branch. Grosvenor Museum, Chester. Wed., 19 April, 7.30 p.m.

Institution of Civil Engineers

LONDON
"The Use of Specialised Plant on Airfield and Road Construction," by E. U. Broadbent and M. A. May. Tues., 18 April, 5.30 p.m.*
"Traffic Planning and Design of Roads in Cumbernauld New Town": Discussion, to be introduced by G. P. Crow. Traffic Engineering Study Group. Thurs., 20 April, 5.30 p.m.*

Institution of Civil Engineers
Institution of Mechanical Engineers and
Institution of Electrical Engineers

LONDON
"Resources, Human and Material, of the British Commonwealth," by the Duke of Edinburgh. Joint meeting of the three institutions at the Institution of Civil Engineers, Great George Street, SW1. Thurs., 13 April, 5.30 p.m. (Open only to members of the three institutions. Tickets required.)

Institution of Electrical Engineers

LONDON
"The Education of Engineers—All's Well?" Discussion, to be introduced by the President, Sir Hamish D. MacLaren. Mon., 17 April, 5.30 p.m.*
"Progress in Oil-Filled Cables and Their Accessories," by Dr. A. N. Arman, Dr. Ing. F. J. Miranda and G. R. Bishop; and "The Influence of Ageing on the Characteristics of Oil-Filled Cable Dielectric," by Dr. Ing. P. Gazzana-Priaroggia, Dr. Ing. G. L. Palandri and Dr. Chem. U. A. Pelagatti. Supply Section. Wed., 19 April, 5.30 p.m.*
"Aluminium in Electrical Engineering," by P. J. H. Rata; "Diesel Railway Locomotives," by A. D. Swanston and B. W. Towell; "Automatic Programming for Hot Reversing Mills," by T. E. S. Rickard. Joint meeting of the Utilisation Section with the London Graduate and Student Section. Thurs., 20 April, 6 p.m.*

BIRMINGHAM
"Development of 'Off Peak Heating' with Particular Reference to Floor Warming," by S. C. Dinenage. South Midland Centre. College of Technology, Gosta Green, Birmingham. Mon., 10 April, 6.30 p.m.

EDINBURGH
"Radio Communication in the Power Industry," by E. H. Cox and R. E. Martin. South East Scotland Subcentre. Carlton Hotel, Edinburgh. Tues., 18 April, 7 p.m.

GLASGOW
"Measured and Electrical Model Characteristics of Buildings Heated by Floor Thermal Storage," by E. D. Taylor, B. Berger and G. Blaylock. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 12 April, 6 p.m.

NEWCASTLE UPON TYNE
Annual General Meeting and Conversazione. North Eastern Centre. Royal Station Hotel, Newcastle upon Tyne. Mon., 17 April, 6.30 p.m.

NOTTINGHAM
"The Power Drive and Control for Jodrell Bank Radio Telescope," by C. N. Kingston, H. A. Prime and H. T. Price. East Midland Centre. The University, Portland Building, Nottingham. Tues., 11 April, 6.30 p.m.

SCUNTHORPE
"Silicon Power Rectifiers," by A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams. Sheffield Subcentre. North Lindsey Technical College, Scunthorpe. Wed., 19 April, 6.30 p.m.

Institutions of Electronics

LONDON
"Modern Transistors and Their Applications," by T. D. Towers. London School of Hygiene and Tropical Medicine, Keppell Street, WC1. Fri., 21 April, 7 p.m.*

Institutions of Engineering Inspection

STAINES
"Inspection": Discussion Panel on questions put forward. South West Group. At works of Petters Ltd., Staines, Middlesex. Thurs., 20 April, 7.30 p.m.

Institution of Engineers-in-Charge

LONDON
"Use of Isotopes in Industry," by J. A. Frampton. Caxton Hall, off Victoria Street, SW1. Wed., 12 April, 6.30 p.m.*

Institution of Heating and Ventilating Engineers

LONDON
Annual General Meeting and Induction of the President for the 1961-62 session. Wed., 19 April, 6 p.m.

GLASGOW
Annual General Meeting. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 25 April, 7 p.m.

Institution of Locomotive Engineers

LONDON
"Work Study and Its Application to Motive Power Activities," by G. O. B. Clarke and W. G. F. Thorley. Annual General Meeting. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 18 April, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Coordinating the Needs of Hydraulic Machinery and Civil Engineering": Discussion. Hydraulic Plant and Machinery Group. Mon., 17 April, 6 p.m.*
"Undergraduate Project Work in Full-Time and Sandwich Courses in Mechanical Engineering": Discussion, to be opened by Dr. R. W. Steed. Education and Training Group. Wed., 19 April, 6 p.m.*

CRAWLEY
"The Small Diesel Engine for Cars," by M. H. Howarth and C. J. Walder. Southern Branch. Pelham Buckle Hotel, Ifield, Crawley. Thurs., 13 April, 7.30 p.m.

MIDDLESBROUGH
"Inspection of Primary Circuits and Reactor Pressure Vessels of Nuclear Power Plant," by H. N. Pemberton and E. Crossley. Repetition of Nominated Lecture. North Eastern Branch. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Tues., 11 April, 6.15 p.m.

NEWCASTLE UPON TYNE
"Inspection of Primary Circuits and Reactor Pressure Vessels of Nuclear Power Plant," by H. N. Pemberton and E. Crossley. Repetition of Nominated Lecture. Annual General Meeting. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 10 April, 6 p.m.

RUGBY
"Controlled Fusion Reactions," by Professor P. M. S. Blackett, presented by Dr. R. Latham. Thomas Hawksley Lecture. Midland Branch. College of Technology, Rugby. Thurs., 20 April, 6 p.m.

Institution of Plant Engineers

BLACKBURN
"Application of New Materials to Plant Engineering," by John Leyland. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 20 April, 7.30 p.m.

CARDIFF
"Fuel Efficiency," by W. Short. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 25 April, 7.30 p.m.

ROCHESTER
"Plastic Bearings," by J. F. L. Ludgate. Kent Branch. King's Head Hotel, High Street, Rochester. Wed., 19 April, 7 p.m.

Institution of Production Engineers

ILFORD
"Chemical and Electrolytic Surface Finishes," by D. Read. South Essex Section. Ilford Conservative Club, 42 High Road, Ilford, Essex. Wed., 12 April, 7.30 p.m.

LIVERPOOL
"New Materials in Industry: Plastics," by E. M. Elliott. Liverpool Section. Exchange Hotel, Tithebarn Street, Liverpool 1. Wed., 12 April, 7.30 p.m.

Institution of Water Engineers

LONDON
"Organisation of an Engineering Department for 16 Regrouped Water Undertakings," by A. Forbes Ilsley; and "Some Considerations on the Siting and Construction of Water Wells," by G. R. S. Stow. Annual General Meeting. South Eastern Section. Institution of Civil Engineers, Great George Street, SW1. Thurs., 6 April, 2.15 p.m.

Junior Institution of Engineers

LONDON
"The Thames Flows to the Lee," by E. G. Abercromby. Fri., 14 April, 7 p.m.*

Liverpool Metallurgical Society

LIVERPOOL
"Continuous Casting of Aluminium Alloys," by Dr. W. M. Doyle. Annual General Meeting. Department of Metallurgy, The University, Liverpool. Thurs., 20 April, 7 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"The Pametrada Hydraulic Transmission," by Dr. T. W. F. Brown, P. H. Cleff and T. A. Andvig. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 21 April, 6.15 p.m.

Reinforced Concrete Association

BIRMINGHAM
"Structural Aspects of Coventry Cathedral," by P. Ahm. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 18 April, 6 p.m.*

Royal Aeronautical Society

LONDON
"A Review of Current Developments in Agricultural Aviation," by Dr. W. E. Ripper. Agricultural Aviation Group. Wed., 19 April, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Road Transport Engineers, 1 Cromwell Place, Kensington, London, SW7. (KENsington 3744)
Institution of Agricultural Engineers, 6 Queen Square, London, WC1. (TERminus 0140)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661)
Institution of Engineering Inspection, 616 Grand Buildings, Trafalgar Square, London, WC2. (WHItehall 0818).
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Water Engineers, Parliament Mansions, Abbey Orchard Street, London, SW1. (ABBey 6740)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)

Something Borrowed, Something Unique

A new 1½ litre Volkswagen with engine arranged to allow for luggage space both front and rear is among recent innovations in the West German automobile industry.

By Gordon Wilkins

RECENT figures show that the troubles of the British motor industry are due not so much to competition from the American compact cars as to the fact that we are losing to Germany an increasing proportion of world export markets. The Economist Intelligence Unit points out that Germany's share of the world passenger exports has risen to 34 per cent while Britain's has dropped to less than 26 per cent.

January was a record month for the West German industry, with an output of 197,367 vehicles, including over 150,000 cars, a rise of 24·3 per cent over January, 1960. Exports rose 40 per cent over those for January, 1960, and now take 48·6 per cent of the output. Current production is now 9,000 vehicles a day, of which Volkswagen make 4,000. Last year VW production totalled 855,000, a rise of 22 per cent, and is now 2½ times as great as that of Opel, their nearest rival.

Ford of Cologne, who built over 192,000 vehicles last year, are now moving up fast, thanks to the success of their new Taunus, which has introduced a new note into the appearance of European cars. The body, styled by an American named Dahlberg, sent over from Detroit, has broken away from the hard, angular lines popularised by Pinin Farina, while preserving their practical advantages of large enclosed volumes and extremities which are visible to the driver when parking.

Volkswagen should further consolidate their dominant position with the new 1½ litre model, shown in Fig. 1, which will start coming off the production lines early in July. The one-litre class, in which the existing model competes, accounts for 53 per cent of German sales and

Fig. 1 The new Volkswagen 1500 may have a horizontally opposed engine installed at the rear.

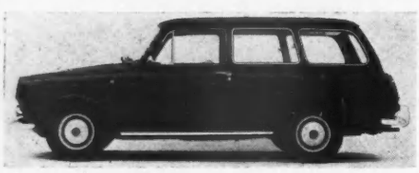


Fig. 2 Volkswagen 1500 station-wagon version.

with the new model they can compete for a further 35 per cent of the market represented by sales of cars up to 2 litres.

Although the two photographs released are carefully posed to avoid revealing much detail, it is known that the new car has luggage trunks at front and rear. Chevrolet, on the Corvair, have shown how the height of a horizontally opposed engine can be reduced sufficiently to get it under the rear floor of a conventional station wagon and something similar has been done on the new Volkswagen. A station-wagon version is illustrated in Fig. 2.

The new power unit, introduced for the existing range, with stronger crankshaft and crankcase, more widely spaced cylinders, larger bearings and a stronger gearbox can presumably be enlarged to 1½ litres by the use of bigger cylinders and pistons without a large new tooling investment.

Production of Mercedes Benz cars increased by 13 per cent last year to total 122,684, but there was a fall in the production of commercial vehicles. There is a delay of several months in delivery of cars on home and export markets and I was told recently that they would work three shifts if they could find the labour.

BRITISH COMPONENTS

The 220SE coupé is the first Mercedes model with disc brakes, using Girling discs at the front with turbo finned drums at the rear. The front wheel suspension with disc brake may be seen in Fig. 3.

Disc brakes are only one of many ways in which British component and accessory manufacturers are obtaining a share in the prosperity of the German motor industry. Two world championships won by British Grand Prix cars have secured much prestige for British component suppliers, and the price situation for some items is particularly favourable, as price fixing agreements oblige German vehicle manufacturers to pay up to 50 per cent more than their British competitors for certain items.

Speaking last year in London, Rudolf Uhlenhaut, a director of Daimler Benz, said they had not up to then adopted disc brakes because they found that, although high-speed stopping was improved, low-speed stopping power was inferior. Their tests gave stops from 19 mph in 12¼ ft with drums and 15¼ ft with discs. It was found that the coefficient of friction with the friction pads on disc brakes was about 25 per cent lower when cold than when they were hot and the existing brake servo could not supply the extra power necessary.

The first step was to put on a larger booster, increasing brake line fluid pressure from 110 to 140 atmospheres. For various reasons, including the ease of obtaining an efficient parking brake, they decided to retain drum brakes at the rear and then the problem arose of the difference in sensitivity between disc and drum brakes, which made driving on ice difficult. Discs begin to work with a very light pressure before the shoes in drum brakes can come into action and when braking on ice it was found that the front discs were locking before the rear drums.

The solution Uhlenhaut adopted was to reverse the usual procedure and put in a pressure reducing valve in the fluid line to the *front* brakes. Satisfactory low-speed braking has now been achieved and the stopping distance from 150 kilometres per hour (93 mph) has been reduced to 407 ft against about 475 ft with all drum brakes.

Although the mechanical and structural parts of the coupé are basically the same as those on the 220 SE saloon, the car is 3 in lower and none of the external panels are interchangeable—not even the wings or bonnet—so that it represents a heavy new tooling investment. It also weighs more than the saloon (3,135 lb at the kerb).

The gear change is by central lever whereas the saloon has it on the steering column, and there are circular dials for speedometer and tachometer instead of the much criticised vertical ribbon speedometer used on the saloon.

Auto Union, who are now amalgamated with Daimler Benz, increased their production in January by 76 per cent over the same month last year, thanks to the output from the new factory at Ingolstadt, near Munich, where three-cylinder two-stroke DKW Juniors are now being made at the rate of 240 a day.

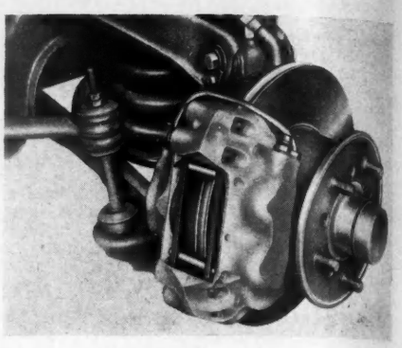


Fig. 3 Front wheel suspension with disc brake fitted to Mercedes-Benz 220SE coupe.

The larger Auto Unions with 1,000 cc engines are made at Düsseldorf where production began after the war when all the previous Auto Union factories were lost in the Eastern Zone of Germany.

Bosch have 11,000 Italians plus some Yugoslavs and Spaniards among the 17,000 workers at their car accessory plant at Stuttgart and are now trying to bring in Brazilian workers to increase the labour force. With their various other factories making electrical equipment and household appliances they now employ about 60,000 workers.

Bosch engineers told me there is as yet little interest in the use of four headlamps in Germany, although the new Ford Taunus is styled to allow their use on exported cars. Transistor ignition does not appear to be on very high priority as the company feel it is too expensive and the same applies to their experimental low-tension ignition systems.

One major difference between Bosch electrical equipment and that on British cars is of course their use of starters with pinions which are positively engaged by solenoids or by hand-operated linkage. Besides giving quieter operation, this design allows the driver to go on turning a reluctant engine which is firing on only one cylinder, whereas the inertia-engaged pinion, which the British industry alone now uses, is thrown out of engagement as soon as one plug fires.

The one flaw in the picture of a prosperous and expanding German motor industry has been the crisis in the Borgward Group, which forced the State Senate of the city of Bremen to step in and back a new company in order to protect the livelihoods of about 20,000 workers. At the age of 70, Carl Borgward has thus lost control of the last great private empire in the European car industry, an empire which he created and owned, and it is not certain what compensation he will receive.

While acknowledging his brilliance as an engineer, his fellow industrialists blame his fall on his failure to adapt his organisation to face increasingly stiff competition. His three main factories, producing Lloyd, Hansa and Borgward cars, had their own boards, with separate design, sales, and publicity organisations and produced far too many different models. For example, Hansa and Lloyd both had non-interchangeable cars with flat-four water-cooled engines and front-wheel drive.

The group is now being reorganised by Dr. Semler, a former economics minister who has already achieved a successful reorganisation of Henschel, the heavy-truck manufacturers, and of BMW, the car and motor-cycle manufacturers, whose car production rose by 55 per cent last year to total 43,965 units.

Preparing the Engineer for Management

Most engineers become managers, but few qualify for higher management. Yet engineers have made a substantial contribution to the development of management tools and techniques.

*By David H. Bramley, M.I.Mech.E.**

If it is accepted that management involves responsibility for direction and control of the work of others, nearly all professional engineers are also managers. This was illustrated some years ago when one of the principal British engineering institutions estimated that over 90 per cent of its corporate members carried some degree of managerial responsibility.

Professor Edgeworth Johnstone's recent scientifically conducted inquiry among members of the Institution of Chemical Engineers[1] disclosed that the matters with which established chemical engineers are most frequently concerned in their daily duties are management, report writing and economics.

On the other hand, it is well known that in the higher ranks of management, engineers are in a minority. In a study of the careers of more than 1,000 public company directors, published in 1955,[2] it was shown that whereas one quarter of the directors had a background of technical experience, three quarters had commercial or non-technical experience. One of the conclusions reached by the Acton Society Trust as the result of its inquiry into the promotion processes of very large companies[3] was that non-technical qualifications had been considerably more advantageous than technical qualifications in reaching top levels of management.

If most engineers become managers but few are entrusted with the responsibilities of higher management, it may be for the reason that engineers are inadequately prepared for the managerial aspects of their work. Much experience supports this view. Here are but a few of the problems which are often the result of poor engineering management:

Excessive delay between conception of design and availability to the user.

Second thoughts and correction of design errors leading to expensive modifications to the product after manufacturing has commenced.

Inability to plan future engineering action on a time base and to secure achievement of plans.

Lack of sympathy between engineering design and methodology of manufacture, resulting in excessive cost and reduced profitability.

Final costs of engineering projects exceeding estimates in substantial sums.

Inability to secure support for technological proposals.

Abortiveness of design expertise through lack of funds or appropriate channels for marketing.

Tardiness of engineering action resulting from technological and human conflicts.

Ineffective use of technological manpower.

Deployment of technological effort unrelated to economic factors.

The elimination or minimising of difficulties such as these is entirely a matter of management, which is just as significant to success in engineering as the technological quality of engineering itself.

HUMAN ELEMENT

Why does the engineer often find it difficult to solve problems of management? To some degree his theoretical training, with its roots in the physical sciences and concerned with substances and mechanisms which can be expected to obey rules, fosters deductive habits of thought which are inadequate for dealing with those problems of management in which the human element is involved.

It is irrelevant to expect that the whole task of management can be accomplished with the aid of the processes of deductive logic: by definition, by testing propositions, by extraction of principles and the formulation of laws which can have a universal validity. To this extent the term "scientific management" has confused the engineer. It is suggested that the engineer must learn a new intellectual approach to be successful in dealing with problems of management.

In point of fact engineers have made a substantial contribution to the development of management tools and techniques. Of the 70 pioneers recognised in *The Golden Book of Management*,[4] no less than 35 were engineers: among these F. W. Taylor, F. Gilbreth, H. L. Gantt, James Rowan, E. T. Elbourne and Hans Renold. The concept of standards which is the basis of modern systems of cost control was developed by engineers, not by accountants.

The engineer in fact probably has more opportunity for developing and practising the skills of management than his counterparts in other professions, and there is now a growing body of opinion that engineers should be encouraged to prepare themselves more sytematically for this task. The initiative in this matter, however, is by no means new, for it is now over 35 years since the Institution of Mechanical Engineers introduced the subject "engineering economics" into the examinations for corporate membership. The title was soon altered to "industrial administration" in recognition of the managerial purposes of the syllabus.

At first this examination could be little more than a test of observation of methods of organising and managing engineering work encountered by a mechanical engineer during his practical training. Later, as the teaching developed, the examination became more demanding.

EXAMINATIONS

The extent to which the other professional engineering institutions have recognised the need for a non-technological and management element in the formal preparation of candidates for professional status can be measured to some extent by the proportion of examination time allotted to management subjects. This is as follows: production engineers 33 per cent, chemical engineers and marine engineers approximately 10 per cent, electrical engineers and civil engineers, nil.

The proportion of examination time allotted to management by the Institution of Mechanical Engineers is a minimum of 18 per cent; for candidates who have chosen a management subject from the elective group of the syllabus it is 27 per cent.

Some institutions have taken the view that time is simply not available for studies which are not directly relevant to basic technology. Others have the opinion that a body of knowledge of management has not yet been developed which can compare on an intellectual basis with the demands made on a candidate by the underlying sciences and the several branches of engineering technology.

Yet another view has been that a systematic study of the tools and techniques of management is more meaningful after an engineer has established himself in his profession.

Sir Noel Hall, however, goes much farther[5] in suggesting that preparation for management should be provided at four different phases in the development of managers, viz., before engaging in the work of industry, upon entering industry, upon taking up managerial responsibility for the first time, and where appropriate in preparation for top management responsibilities.

If these opinions all carry weight, if it is of real importance to prepare engineers more effectively for their ultimate responsibilities as managers, then it may be necessary to extend syllabuses and the length of courses in the universities and colleges to permit this to be done. The teaching institutions must receive even more encouragement to accept responsibility for the initial phase of introducing engineers to the tools and techniques of management and to the integration of economic, financial, social and psychological knowledge which they must learn to use for success in their task of managing. In the British scene this encouragement will be the more effective if it comes from the professional engineering institutions and written into standards for admission to corporate membership.

For engineers already carrying managerial responsibility there are now a number of ways of gaining access to a knowledge of the philosophy, processes and techniques of management. Many of the larger British enterprises have set up staff colleges where short courses on managerial subjects can be given to all executives at given levels of responsibility.

There is likewise a growing number of facilities for management education offered by universities and colleges, by separate institutions such as the Administrative Staff College and by management consultants, in all of which a substantial proportion of those participating are engineers. There is a steady growth in facilities provided by management consultants for training executives in management techniques—a relevant example is the training of civil engineers in management and productivity methods related to their own industry.

Probably the most practical and effective training in management undertaken by engineers in the British Isles is the preparation undergone by those who offer themselves and are selected for management consultancy work. Coming as it does after a number of years of executive responsibility this instruction can be fast, comprehensive and thoroughly practical.

Although these several facilities for assisting in the development of managers in Britain appear to be satisfying the demands made upon them, it has to be recognised that they fall very far short of the need.

ON THE JOB

Nevertheless, management is a very practical task and to some degree it must be learned on the job. However well disciplined is the intellectual preparation for management, the way in which an engineer practices as a manager depends principally on what he learns from the good or the bad managers he works under. This must be recognised by those responsible for his development by ensuring that he works under well-chosen influences. It must also be recognised by the engineer himself, by constantly taking advantage of any opportunity to evaluate the quality of his experience.

This perhaps gives us one of the principal justifications for attempting to formalise the preparation of engineers for the task of managing, viz. to provide them with a systematic framework of knowledge by which to evaluate their experience.

* Formerly Head of the Department of Industrial Administration, College of Advanced Technology, Birmingham; now Head of the Urwick Management Centre.

References

[1] R. Edgeworth Johnstone, "A Survey of Chemical Engineering Education and Practice." Paper presented to the Institution of Chemical Engineers, London, 24 January, 1961.

[2] G. H. Copeman, *Leaders of British Industry*. London: Gee & Co., 1955.

[3] Acton Society Trust, *Management Succession*. London: The Trust, 1956.

[4] L. Urwick (Ed.), *The Golden Book of Management*. London: Newman Neame, 1956.

[5] Sir Noel Hall, "Objectives and Methods of Management Education: Four Stages of Management Development." Paper prepared for the Seventh International Conference on Business Management Education. Paris: European Productivity Agency, 1960.

Speaking to People through Their Skins

Speech can be processed into vibrations that can be understood through the skin. An additional channel for passing information to people is thus available. It could be used where seeing or hearing is impaired.

PEOPLE mostly pick up information by using their eyes or ears. But they also have other sensory organs—responding to touch, smell, taste, for instance. These do not handle anything like the same amount of information and the question arises whether they are being exploited efficiently enough. Could not a great deal more information be transmitted by touch, for example? This would be a useful third channel where the visual and auditory channels are already carrying too great a load, or when one of these channels has been damaged or experiencing interference.

The sort of situation where such conditions can be found is in high speed aircraft and probably, in the future, in manned rockets. High noise levels around jet or rocket engines reduce the effectiveness of a speech channel very much. Because of this the Rome Air Development Center, United States Air Force, are looking into the possibility of using a "touch" channel. They want to develop a means of rapid communication through the skin. The familiar nudge in the ribs, while effective, is limited in the amount of information it can pass. What they would like to do is to actually talk to people through their skins, using mechanical vibrators. RADC research has shown that the reception of processed speech by the use of skin vibrations may be developed for use in communications.

Several different approaches have been tried in past attempts to develop a tactile communications system. Electrical stimuli have been used, but mechanical stimuli have been most fruitful. Two different approaches have been made: applying speech energy directly and applying coded energy patterns.

The theory behind attempting the direct use of speech energy was that both the ear and skin developed from ectodermal tissue, with the skin being ontogenetically the older. Therefore anything the younger ear could do, the skin could do, but this idea ignored the facts of skin response.

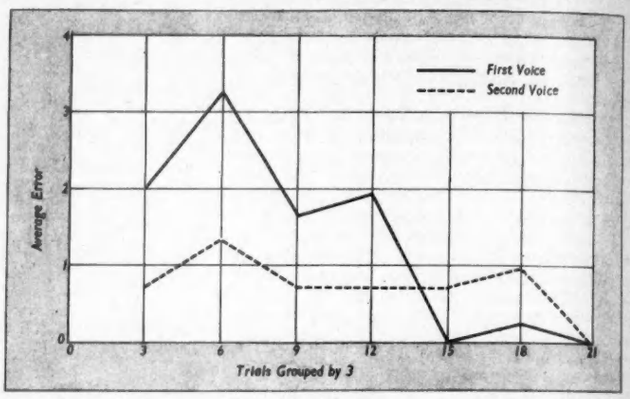
The sensitivity of the skin is quite high in the 50-500 c/s range. At those frequencies the displacement amplitude threshold is about 10^{-6} cm. At frequencies of 10 and 1,000 c/s the threshold is about 10^{-3} cm amplitude. While the displacement required is not large, obtaining sufficient displacement to bring the vibrations at extreme frequencies above threshold may result in exceeding the pain threshold at other frequencies. However, a range of 15-1,500 c/s is considered sufficiently wide to include most stimulus situations.

The trouble is that speech intelligence and hearing sensitivity are centred in the low kilocycle frequency range. As the skin is most sensitive in the lower frequency region of 50-500 c/s, only the fundamental and first few harmonics of speech can be felt. Even these are likely to be near the higher, less sensitive, end of the skin response range.

Great ingenuity has been used in developing techniques and devices to apply the vibrations of speech to the skin. Gault's teletactor is possibly the best known method. Gault used separate vibrators for each finger in conjunction with a different frequency band for each vibrator. With such techniques some limited success was achieved, but no general communication technique has been developed using unmodified speech applied directly to the skin.

The second approach, that of coding, is based on a more careful look at the realities of skin behaviour. By using frequency, intensity, duration and position, an arbitrary code can be devised. Such a system was that developed by Geldard, which used all of the above variables in an alphabet code and obtained a data rate of 30 words per minute. Unfortunately, coding of this nature introduces technical complexity as well as the need for training of the sender.

If speech could be shifted into the proper frequency range, the skin might be capable of making the necessary discriminations. With the average male voice having a fundamental frequency of about 125 c/s an eightfold reduction in frequency would bring the entire speech pattern into tactile range. A new fundamental frequency of 15 c/s is near the lower limit.



The ability to generalise touch sensations: after being trained to recognise 6 phonemes spoken by one voice, the subject made fewer errors when being trained to recognise the same phonemes spoken by a second voice.

In a paper "The Feasibility of Speech Transmission Using the Skin as a Sensor," Richard Newman, of RADC, explains that the technique used for reducing speech frequencies was to record speech on a tape recorder and then re-record at half speed. Three reductions produced the eighth-speed tapes. The tapes were then played through an amplifier to a vibrator. The vibrator held a brass or plexiglass strip, which contacted the subject's fingertips. This strip acted as a small loudspeaker. To avoid auditory cues reaching the subject, random noise was fed to his ears.

In working with speech, at least two approaches were possible. The stimulus material could be either words or simple speech sounds (called phonemes). Initially both were tried, and eventually phonemes were selected. The use of phonemes offers greater potential flexibility than the use of specific words, and appears no more difficult to use.

DIFFERENT VOICES

Basically, two types of experiment were carried out, for which two sets of tapes were prepared. The first set consisted of 15 words, the numbers zero to nine and the list of English phonemes. One presentation of each word and phoneme was included. These tapes were used for experiment I. The second set of tapes included 12 phonemes, chosen for their high frequency of usage. These 12 phonemes comprise over 60 per cent of the English language speech sounds. They were recorded by three different speakers, each individual pronouncing each phoneme 21 times to provide a master list and 20 randomly permuted orders. Ten of these were randomised orders of all 12 phonemes, and were referred to as the "full lists." The other 10 lists were split in half and each half randomised separately. The initial split was with the intention of making the first group of six easier to discriminate than the second six. These lists were referred to as "series A" and "series B." Series A proved to be far more easily learned than series B.

In experiment I three subjects were trained initially to differentiate 15 words and the numbers zero to nine. The words were presented in groups of five and then combined. Each group was presented to the subject who made an immediate response and was corrected, or told that he was right. The subjects were then trained on 17 randomly selected phonemes.

Experiment II dealt with the ability to generalise when the variation in speech that occurs with repetition of a phoneme by one speaker is present, and when different speakers are used. Each subject was first trained on one voice using the three lists, and then on a second voice in the same manner.

The subjects in experiment I attained accuracy levels of over 85 per cent on both the words and phonemes, with two of them exceeding 90 per cent. No more than 30 trials were required to learn either the phonemes or words. With the high redundancy of English speech, these results could exceed the minimum requirements for a basic communications system.

The second experiment was concerned primarily with generalisation of the stimulus phonemes under the variation introduced by having the same speaker repeat the phonemes, and by using different speakers. This generalisation has been clearly shown to occur. The criterion for learning was at least 90 per cent correct responses for three consecutive trials. All subjects accomplished this for a given voice.

The ability to generalise a voice's variation is based primarily on generalising differences in intensity and duration. There were no major shifts in frequency where one speaker was concerned, and no major speech pattern changes. Intensity variations were as much as 2 to 1 for some phonemes on different presentations. These results indicate that tactile discrimination of phonemes can be generalised. In this respect, lowering the frequency to one-sixteenth of normal did not destroy the discrimination or affect the error frequency.

Of greater importance is the performance on consecutive voices. The differences to be found in a single voice are smaller than those between two voices. In using two speakers, we greatly increase the variations in frequency and speech pattern. The graph shows the average errors for one subject. In this case, the number of trials required to learn second voice was not reduced. The subject still required 21 trials. However, the average error is lower, only once exceeding an average of one error per trial.

The future of this technique looks promising. Under environmental conditions of extreme noise, or where normal sound transmission is either difficult or undesirable, tactile reception may prove most useful. But before it can be put into use more research will be needed. The effects of the transitionals found in words, the use of speech chopping to increase the data rate (at present only one-eighth that of normal speech), and the possible use of selective amplification and frequency filtering must be examined.

Human Element

European Consultants Study British Methods

EUROPEAN management consultants from nine countries are ending a three week visit to Britain in which they have conferred with consultants from the leading companies and covered a very wide range of the work done in this country.

The "training mission" sponsored by the European Productivity Agency, an OEEC body, was organised by the Management Consultants Association which includes leading management consultancy firms, employing 1,200 consultants serving 6,000 industrial and other concerns in Britain and abroad.

The broad field of consultancy services studied by the European team ranged over recruitment and training, operational research, marketing, industrial relations, automation, mechanised office equipment and computers, financial control and training for promotion. At the headquarters, in Bloomsbury, of the Trades Union Congress, the European consultants and their British counterparts, discussed working with trades unions and the contribution management consultants and trades unions can make towards increasing production.

The Benefit of Work to the Elderly

The amount of work that can be done by old people is small and likely to remain so. But the satisfaction that the elderly derive from a few hours work a day is obvious and the indirect saving to the community may be very great.

The indirect saving comes about in this way. The older person, perhaps with no feeling of purpose in life, who falls ill as much from loss of morale as from any other cause, will cost an average of £11 a week in a geriatric ward—£572 a year. On the other hand the annual loss on maintaining employment for an elderly person in a workshop is only £18.

This stimulating comparison comes from the report *Employment and Workshops for the Elderly*, which is published by the National Council of Social Service (price 1*s*). Frankly enough the report points out that workshops for elderly people are likely to be rather expensive to start.

Securing Support

The National Old People's Welfare Council, for whom the report is published, acknowledge that workshop schemes for elderly people will benefit only a relatively small number of people and should not therefore be allowed to prejudice other fund-raising for old peoples' general welfare. It is essential, says the council, that before launching out on such schemes adequate financial backing, in the form of grants and local generosity, should be definitely known to be available.

At Finsbury the pioneering scheme began in 1951 is now a well established part of the scheme of things. Its balance sheet is that during 1959/60 income from outwork and sales was £1,850 while wages took £2,624, materials £117. The cost of maintenance, salaries, lighting and heating was covered by a grant from the Finsbury Borough Council of £1,200, another from the Employment Fellowship of £400, and contributions and donations which brought in another £1,308.

The Finsbury scheme employs 120 elderly people, with an average age between them of 71 and 74. Wages are 10*s* a week and the workshop is open for two hours in the morning and two in the afternoon five days a week. Items made directly for sale include covered coat hangers, night dresses and aprons.

Education for Science in Industry

Another well known figure has joined the ranks of those urging more training facilities producing highly qualified technologists able to apply scientific disciplines and discoveries in industry.

The voice is that of Sir Andrew McCance, F.R.S., who is chairman and managing director of the Colville iron and steel company. Sir Andrew's quarrel with educationalists in Britain is that for too long they have clung to the belief that a training in theoretical science was sufficient. Abroad there were many countries with centres, of independent university status, concentrating on technological studies of the use of science in industrial progress.

Nearer home Sir Andrew, in his address to the Royal Society of Arts earlier this month, drew on the steel industry to demonstrate how staff needs were in step with rising production, while proportionally fewer were needed in the overall labour force.

Steel output in 1950 had been 16,200,000 tons, 296,000 people were employed and the number of staff was 34,810. In 1960 steel output had risen to 24,200,000 tons, there was a total employment of 326,000 and the staff had increased to 51,000.

More and More Staff

This amounted to a 50 per cent increase in output, 10 per cent more in the labour force, but 46·5 per cent more in the staff needed. The clear inference of these trends is that more machinery for production leads to increasing need for supervisory and planning staff, but for fewer operatives per unit of production (though it should be added that the total employed also rose, but more slowly).

Automatic handling of the management side in iron and steel has gone a long way but there are still intractable problems, requiring the presence of technically educated people for their solution.

Private Development of Public Property

Sharply rising land values and no less increased public concern in the best possible running of the railways has focused a greater amount of attention on the development of the extensive railway properties.

The eventual decision of the Minister of Housing, Mr. Henry Brooke, who has been showing considerable willingness to vary the recommendations of his inspectors, on a scheme for the development of an office block partly over railway lines at Gunnersbury station, in West London, may be of great significance in the way in which the potential of railway owned property is developed in future.

The £1 million Gunnersbury scheme, sponsored by a private group, is for a 20 storey office block, developed under lease from the British Transport Commission. The block would be in part over the track at Gunnersbury station. Included in the L shaped block would be a new station, car parks for 380 vehicles, a restaurant and filling station.

Total floor space would be about 200,000 sq. ft. After taking out the space for the station there would be about 140,000 sq. ft for letting. Middlesex County Council have rejected the scheme, partly because the greater part of the area involved is not zoned for business use (much railway land is zoned for railway purposes only) and that the scheme would be likely to add to congestion in an area where there has already been a large amount of office building granted.

The inquiry, before an inspector of the Ministry of Housing, was held earlier this month after the British Transport Commission had appealed against the rejection by the Middlesex authorities. It is the first such case of its kind outside central London.

The Bigger the Firm the Higher the Absence

That absence from work increases with the length of the working week is probably the most important conclusion to be drawn from a valuable report published by the British Institute of Management, *Absence from Work—Incidence, Cost and Control*. Some seventy companies provided returns for the year from July, 1955, to June, 1956, and a smaller group of eleven firms were the subject of an analysis of the cost of absenteeism. This was found to vary from 9*d* to 15*s* a week for each individual employee. Five of the eleven firms found that the individual cost was above 5*s* per week.

The BIM report declares that more than one million workers a day are absent from their work. This means that each day about one in every twenty is not at his place. If the lost production is even vaguely in ratio to the numbers missing from work the cost must be enormous.

In detail the survey shows substantial variations in absenteeism; between men and women, according to geographical area, size of firm and time of year. Not surprisingly the worst month for absence from work was found to be February.

Overall absence for women was 6·4 per cent, against 4·1 per cent for men. Away from work more often than the men, women tended to return more quickly. Slightly over 70 per cent of the absences from work were put down to sickness by both sexes. Men were absent due to accidents three times as much as women, Absence due to accidents among the men was 7 per cent, among women 2 per cent.

Cut out Saturday?

On the important point of the length of the working week, firms working the five and a half day week suffered 20 per cent more absenteeism among women workers than those with a five day week. There was also a general increase in absenteeism by men working the additional half day. Only a limited amount of this extra absence was put down to illness.

The BIM suggest that the abolition of Saturday work could sharply cut down absenteeism with no corresponding cut in output, possibly there would be an improvement.

The lowest absence rate was found among the small firms, the highest in the largest. The report recalls that a low absence frequency has been noted as one of the results flowing from the high level of morale often discovered in working groups of limited size.

Among the geographical differences it was found that absence among women in the London and South-East was higher than in any other area; a possible effect of longer journeys to work.

Absence from Work—Incidence, Cost and Control is available from the British Institute of Management (10*s* 6*d*, or 8*s* 6*d* to members and subscribers).

MIT Celebrates its Centenary

Centennial week, to be held early next month, by the Massachusetts Institute of Technology will be celebrated with an assembly of many of the leading engineers and scientists from the United States, Great Britain, from the USSR Academy of Sciences, and from other countries.

With six Nobel prize winners among the visitors, a series of discussions will be held on four major topics. They are:

Scientific and engineering education in newly developing countries,
Scientific and engineering education in countries with more advanced technologies,
Interaction of science, engineering and society,
Implications of science and engineering for international relations.

Atoms for Peace

Mr. Harold Macmillan, the Prime Minister and Chancellor of Oxford University, is to deliver an address to MIT at the end of the week. On the previous day Sir John Cockcroft, Master of Churchill College, Cambridge, formerly director of the United Kingdom Atomic Energy Authority at Harwell and a Nobel physics prize winner, is to receive the $75,000 atoms for peace prize.

Sir John will be taking part in a discussion on the future in the physical sciences. Also taking part will be Rudolph Peierls, professor of mathematical physics at Birmingham University, a winner of the Royal Medal of the Royal Society.

£500,000 for Vauxhall Workers

Vauxhall Motors, of Luton, are paying more than £500,000 to their employees this month under the company profit sharing scheme.

The average payment to each employee, less tax deduction, will be £23 16*s*. This is much the same as in the previous year although since then there has been the slump in motor sales. Vauxhall's number of workers who are eligible for the profit sharing scheme has risen by about 2,300.

No-Bolt Linings Halve Tunnelling Time

Experimental lengths of tunnel for London's new underground railway show that tunnel construction times may be halved by using no-bolt segments. Both cast iron and precast concrete linings have been tried. Drum type shields have also been employed.

Two experimental tunnels are being built in good London clay at about twice the speed and more economically than with earlier methods. The tunnels are being driven by London Transport to give full-scale experience of methods of tunnel construction in readiness for the posed Victoria Line and other future tube lines. The new methods would save some millions of pounds on the cost of the 11½-mile line. An excellent colour film of the work has been made the the Film Section of the British Transport Commission, clearly showing the different stages in the work. The commentary is particularly well composed and succeeds in drawing attention to interesting features as the film progresses.

It is 21 years since a new section of tube railway was built by London Transport and 54 years since the last tube railway across central London was built. In the interim period new knowledge of the stresses and strains in tunnel linings has been obtained by tests including the removal of original linings; as a result designs, of lining have been evolved entailing new methods of tunnelling.

Contracts were therefore placed early last year for the construction of two experimental lengths of twin tunnel, one running northwards from Finsbury Park to Manor House and the other southwards from Netherton Road (Tottenham) to Manor House, where the two lengths of tunnel meet. The total length of twin tunnel involved is about one mile, and the cost will be about £1 million.

The Finsbury Park to Manor House section is being lined with concrete block segments of a new pattern and the Netherton Road to Manor House section uses a new type of flexible jointed cast iron lining without bolts and with much shallower flanges than those of conventional linings. Views along the two tunnels are shown in Figs. 1 and 2. Previously, tube tunnels have been lined with bolted cast iron segments built inside a shield and with cement grout forced into the space left as the shield moves on between the outside of the segments and the surrounding ground. Although reliable, this method is slow and expensive; it would be adopted locally if the tunnels had to be driven through patches of poor ground that were not self-supporting.

Consulting Engineers and Contractors

Concrete Lined Section,	**Finsbury Park to Manor House**
Consulting Engineers	Sir Wm. Halcrow and Partners, Alliance House, London, SW1
Contractors	Kinnear, Moodie & Co. Ltd., 299 Hither Green Lane, Lewisham, London, SE13
Manufacturers of Concrete Segments	Charles Brand & Co. Ltd., 25 Charles II Street, London, SW1
Cast Iron Lined Section,	**Netherton Road to Manor House**
Consulting Engineers	Mott, Hay & Anderson, 9 Iddesleigh House, London, SW1
Contractors	E. Nuttall, Sons & Co. Ltd., 22 Grosvenor Gardens, London, SW1
Manufacturers of Cast Iron Segments	Stanton Ironworks Co., Ltd., Stanton-by-Dale, nr. Nottingham Head Wrightson Iron Foundries Ltd., Thornaby-on-Tees Smith Patterson Co. Ltd. Blaydon-on-Tyne, Co. Durham The Anderton Foundry Co. Ltd., Middlesbrough
Manufacturers of Shield Equipment	Kinnear, Moodie & Co. Ltd., Lewisham, London, SE13 Arthur Foster (Constructional Engineers) Ltd., East Ham, London, E6

Fig. 1 In foreground, the new no-bolt cast iron linings, to be contrasted with the conventional rings in the background.

Fig. 2 The new concrete lined tunnel; note the wedges in the soffit. As the segments have no ribs, the tunnel has a clean bore.

The tunnels are being bored by a rotary type of shield called a " drum digger " which can work much faster than any previous shield used for tube railway construction in London; it is also provided with conveyors to remove the spoil.

Using the cast-iron lining method, the contractors for the eastern half of the tunnel, Edmund Nuttall Sons and Company (London) Limited, have completed driving a 934 ft length of tunnel, including the excavation and lining, in two weeks. This, representing a speed of 3½ ft of new tunnel built per working hour, is believed to be a world record for driving and lining a tunnel of this size through clay soil. It is about double the speed which would be considered good going with previous techniques.

One drive of each type of tunnel has now reached Manor House, where a cross passage has been built connecting the two. This passage enables the survey traverse to be closed at tunnel level. Work is now complete on the second drive from the Netherton Road end, and the drum digger has started on the second drive from the Finsbury Park site.

The work is being carried out to the requirements of Mr. C. E. Dunton, M.A., M.I.C.E., Chief Civil Engineer, London, Transport. The consulting engineers and contractors for the two two sections are shown in the table.

TUNNELLING EQUIPMENT

The drum digger type of shield, which was developed by Kinnear Moodie and Company Limited and Arthur Foster Constructional Engineers Limited, has been used previously on the tunnelling work for the Metropolitan Water Board's Thames to Lee Valley water tunnel, for which Sir William Halcrow and Partners were also the consulting engineers. The experimental railway tunnels are of considerably larger diameter than the water tunnel, and the drum digger shields are therefore on a larger scale. The general design, however, has remained unaltered.

The drum digger for the concrete-lined tunnels has an external diameter of 14 ft and that for the cast iron lined tunnels 13 ft 1 in, both for nearly the same internal diameter. The difference in the volume excavated—14 per cent—may well prove to be a critical factor in choosing between the two types of segment.

The drum digger consists of two drums. That for the 14 ft diameter tunnels has an outer drum of 14 ft external diameter by 9 ft in length, the leading end being bevelled to form a cutting edge. Within the main drum is a 7 ft 6 in diameter rotating drum, 5 ft 6 in in length, carried on two roller races and provided with a thrust ring to take the axial load from the rotating cutters.

The cutting teeth themselves are mounted on six arms at the front of the shield, each carrying eight removable teeth, as shown in Fig. 3. The arms are mounted at the outer edge of the inner rotating drum, so that they cut the area between inner and outer drums. The area in front of the inner drum is cut by teeth mounted on a removable arm across the diameter of the inner drum; so that a uniform cut is obtained over the whole face, the distribution of the teeth along the arms varies from arm to arm. The teeth may be replaced after hand mining a small cavity in front of the arms. The inner drum, and the cutting teeth with it, can be turned at speeds of up to 4 rpm by six hydraulic motors driving through gearboxes, pinions at the driving ends of the gearboxes engaging a large gear ring bolted to the rotating section of the drum digger. The hydraulic motors are controlled by a valve within the shield.

The forward movement of the shield is obtained by 14 hydraulic rams spaced equally round the periphery of the shield (Fig. 4) and pushing against the last completed tunnel ring. These rams, which have a stroke of 2 ft 8 in and operate at a working pressure of about 2,000 lb per sq. in, are invididually controlled to obtain the correct direction of travel by an operator standing within the shield casing but behind the rotating inner drum.

The clay is cut by the rotating teeth and guided by scoops and paddles into a hopper within the shield, where it drops on to the end of an inclined electrically-driven belt conveyor. This discharges on to the main horizontal belt conveyor which carries the spoil back along a staging, from which it is discharged into skips.

Under the conveyor staging is a 200 hp electric motor driving pumps to provide hydraulic power for the shield motors. A separate 12½ hp electric motor supplies hydraulic power for the rams. At the sides of the conveyor belt, at the shield end, are electric hoists for handling the tunnel lining segments.

The whole of the apparatus, from immediately behind the shield to the rail ramp at the rear, is mounted on an articulated trailing platform attached to the rear of the shield and drawn forward as the shield advances. When the rams have pushed the shield forward the width of a ring of tunnel lining, i.e. 2 ft, they are retracted. A new ring is built in the space between the last completed ring and the rear of the shield (Fig. 5). When this has been completed the whole cycle recommences, the rams pushing against the newly installed ring.

The drum digger is capable, in good conditions, of advancing more than 60 ft a day, working three eight-hour shifts, over long periods—a much higher speed than has ever been maintained

before in building a tube railway tunnel. The maximum length driven to date in one 24 hour period is 88 ft.

CONTROLLING DIRECTION

The ram operator is provided with sighting guides which show him whether the shield is on the correct line and level and he can apply or reduce pressure to any of the rams to correct any tendency to deviate to the right or left or up or down. The sighting devices used on the two shields employed in the experimental tunnel are different, the more elaborate being arranged so that the ram operator can sight the image of a cross of light on a graduated mirror and obtain a direct indication of any deviation from true line or level. The source of light is a lamp placed further back along the tunnel from which a beam passes through two cruciform slits in markers fixed to the roof of the tunnel and located precisely by surveying instruments. When driving a curved length of tunnel, the mirror sighting device is adjusted against a scale after each ring of lining is erected to keep the shield on the proper alignment.

CAST IRON LINING

The lining of the tunnels built from the Netherton Road site is of unbolted flexible jointed cast iron segments. There are six segments, each 1 in in thickness, to very 2 ft tunnel ring. One end of each segment is concave and the other convex, so that the ends of the segments form knuckle joints, each fitting into another. Details of the section and joint are shown in Fig. 6, as well as completed rings in Fig. 1.

The segments are put into place in the space left behind the shield when the rams are withdrawn. The two segment forming the invert or floor are laid first, then the side segments, and finally the segments forming the roof are manhandled ito place and held by " needles " mounted at the rear of the shield. The two segments forming the invert are cast with small recesses at their upper ends and when the segments have all been erected, hydraulic jacks are fitted into these recesses and a force of 15 tons per jack applied to the segments, so expanding the ring against the clay outside. This expansion creates a small gap between the segments forming the sides and those forming the invert of the tunnel. As shown in Fig. 6, the gaps are filled by, first, two cast-iron knuckle-pieces, shaped to conform to the contour of the segments below, and then by two pairs of hard driven cast-iron taper packings which hold the whole ring firmly in place when the pressure of the jacks is released.

The segments have shallow interior ribs which are enlarged to form perforated lugs at regular spacing round the periphery of the ring for handling purposes and to provide, in due course, for fixing railway equipment, e.g. signal equipment and cable brackets, noise reduction screens and tunnel lighting. The internal diameter of this type of lining, from rib surface to rib surface,

Fig. 3 The front of the shield, showing the cutting teeth on the rotating arms.

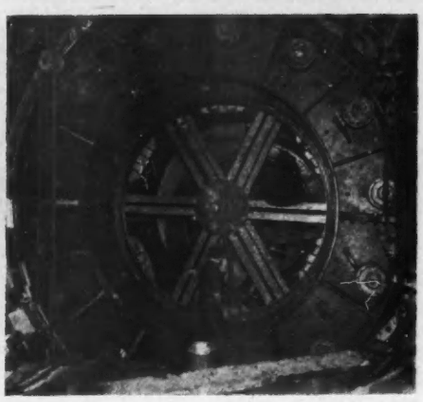


Fig. 4 Erection of drum shield, showing the hydraulic rams which drive the shield forward.

is 12 ft 8 in. This is somewhat more than is absolutely necessary but the external diameter is the same as that required for the conventional cast-iron lining which may have to be used on certain lengths where there are junctions, cross-passages, or other special features. Furthermore, the conventional lining, of 12 ft internal diameter, has deep recesses which can be used to accommodate comparatively bulky signal equipment and other apparatus. The recesses in the flexible jointed cast-iron lining are shallow, so that all equipment necessarily stands out from the inner surface of the tunnel lining.

CONCRETE LINING

The precast concrete lining of the other half of the tunnels is also of a new type. The tunnel itself is being driven by the larger of the two drum diggers, to give space for a tube of 12 ft 6 in internal diameter with a lining of precast concrete segments, of which various thicknesses—from 4½ in to 9 in—have been tested. The final thickness to be used for the Victoria Line may be 6 in. Apart from the key, the segments are completely unreinforced.

Each tunnel ring is made up of 14 identical segments having one end convex and the other concave, so that they fit together with knuckle joints similar to those used for the iron segments (Fig. 7). When the 14 segments are assembled, a gap of about 7 in remains at the top. This gap is filled by a pair of reinforced concrete folding wedges having plane contact faces and concave and convex faces respectively in contact with the segments on each side. The wedge with the wide end nearer to the shield is driven home by a pair of small hydraulic rams while the other wedge is held in position. These two wedges hold the whole ring firmly in place.

The concrete segments are cast with four holes equally spaced round the interior circumference. These are used for handling in the tunnel and will also be used, with expanding bolts, for fixing tunnel equipment, serving the same purpose as the ribs of the cast-iron segments. The concrete segments are handled by hoists at the working face, an expanding bolt placed in one of the holes being used to lift them. They are lifted into their correct positions by a manipulator arm mounted at the rear of the shield and held in place by pull-out needles until the wedges are driven into position.

No grouting is used with either of the tunnel linings and there is nothing between the rings, except that wood packing pieces are inserted between the cast-iron segments to distribute the thrust of the shield rams.

Fig. 5 Erection of the cast iron segments. It has been found economical to manhandle the soffit segments into position.

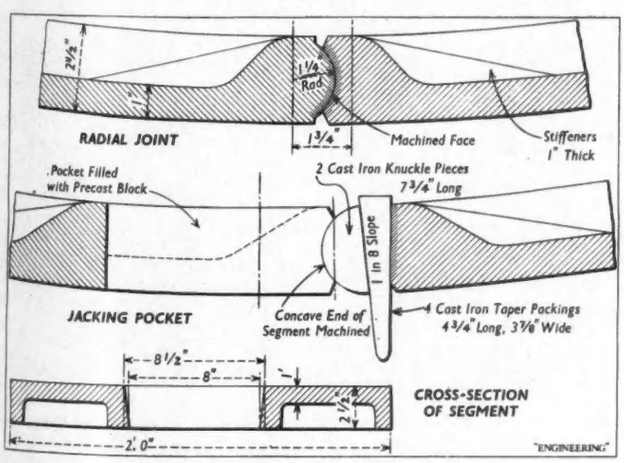


Fig. 6 Details of the flexible cast iron lining.

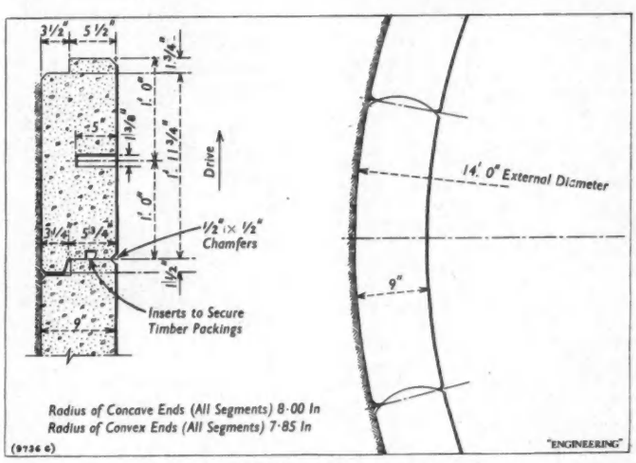
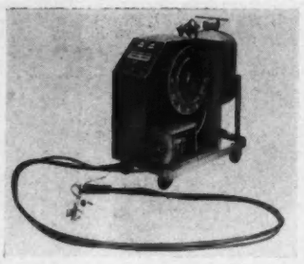


Fig. 7 Details of the concrete lining.

SQUIRT WELDER

Power Driven Gun



HIGH WELDING speeds and deep penetration are claimed for the Idealarc submerged arc mechanised squirt welder.

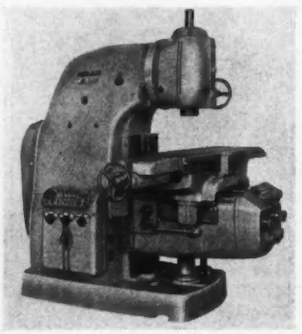
Although hand guided the gun has a drive wheel powered from a small motor that gives an even rate of travel along the weld. The speed is adjustable, from 0 to 70 in per minute. Flux for the submerged arc is fed from a 100 lb capacity tank, the amount fed being controllable by tilting the gun or altering the height of the travel mechanism. To start the flux flow, the trigger bar on the handle is pressed; when pushed forward, the trigger starts the travel motor, the electrode feed and also switches on the power supply.

The gun is supplied from the ML-3 unit which contains the flux tank and the electrode reel. The flux is fed by air pressure to the gun and the electrode wire by a motor having a pressure type V-groove drive wheel. The speed is automatically controlled to maintain the set arc length. The reel holds a 60 lb coil of $\frac{1}{16}$ or $\frac{5}{64}$ in electrode and is fitted with a brake to prevent overrun. The unit is joined to the gun by a 15 ft length of cable. Welding currents are adjustable up to 750A, power being supplied from a separate source such as the SA-750 unit which will also provide the 115 V ac control supply. Arc voltage and inching speed are set up on the control unit, but the current is set on the power source. A voltmeter and ammeter are included.

Butt and fillet welds can be made in materials from $\frac{1}{8}$ in thick upwards. A $\frac{1}{4}$ in flat butt can be run at a speed of 50 in per min or a $\frac{1}{4}$ in flat fillet at 10 in per min. *Armco Limited, 76 Grosvenor Street, London, W1.*

VERTICAL MILLING MACHINE

Switch Controlled



THE milling machine MFP-320 is designed for medium and large batch production work.

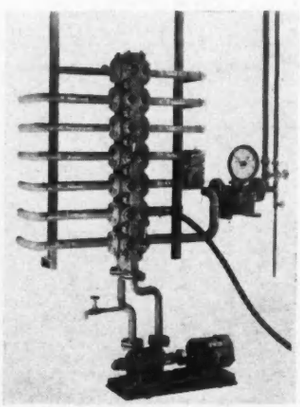
The machine has a work table measuring 320 by 1,250 mm and a range of 20 spindle speeds from 19 to 1,500 rpm. Feed rates are preselected with separate dials, and gear shifting is performed automatically by an electro-hydraulic mechanism actuated by a push button. All movements are controlled from two stations, one at the front and the other at the left of the machine.

Both conventional and climb milling operations can be carried out. The vertical milling head is flange mounted on the top of the frame and can be swivelled through 90° in both directions by a hand operated worm drive. Angular settings can be read off a scale on the flange. The spindle is bored out to 17 mm and is mounted in tapered and cylindrical thrust bearings. Direction of rotation is changed by reversing the motor.

Automatic cycles can be set up from switches and stops, using a punch card system. For example, reciprocal milling can be carried out and also internal and external box milling in both horizontal and vertical planes, in which inching is automatically engaged to give tripping to an accuracy of ± 0·03 mm Interrupted milling can also be carried out. The machine also incorporates automatic lubrication and coolant equipment. *Technoimpex Foreign Trading Company, Budapest 62, PO Box 183, Hungary.*

CONTROL UNITS

For Liquid Distribution



THE illustration shows a bank of control units for distributing liquids through a pipeline system.

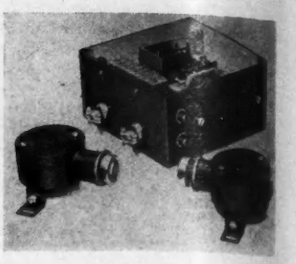
The porting system is such that any one pipe can be connected to any other by way of the pump, and the liquid flow can be in either direction. The great advantages of the arrangement are in he simplification of pipework—only a single connection is required to each tank for both flow and return—and the reduction in the number of valves needed to control a complete system with only a single pump.

Each individual unit has two opposite flanged connections for the pipelines and two other connections for the addition of further units. There is a connection piece with flanges for the pump lines. In each flanged connection is a gate valve with three positions: suction, delivery and closed. Correct connections are ensured by having only two control levers for the whole assembly and these levers can only be removed from a valve if it is in the closed position.

A container with a flushing medium attached to an additional unit permits the system to be flushed out when required. Pipe sizes at present available range from 40 mm (1·58 in) to 100 mm (3·95 in) in five steps. *Douglas Ellison Limited, 8 The Mall, Ealing, London, W5.*

PHOTOELECTRIC DETECTOR

High Sensitivity



HIGH sensitivity and low cost are claimed for a new photoelectric detector equipment, type CF69A.

It consists of a control box and two heads, the projector and receiver. The box is of pressed steel and measures 6 in by 6 in by 3 in. It houses the transistorised control unit, transformer, rectifier fuses and terminal block. Operation can be from 250V mains or from a 12 or 24 volt battery. Consumption is low—of the order of 0·3 watts. The unit is stabilised so that mains variations up to ± 10 per cent do not affect the operation.

The projector head is a robust casing with an adjustable lens carrier for focusing. It is mounted on two swivel brackets for alignment. The 24V lamp has a guaranteed life of 5,000 hours and the 3 watt rating gives a beam up to 6 ft. Lamps of 6 watts will give beams up to 20 ft.

The beam detector head is similarly made and has the phototransistor shrouded so that it is unaffected by extraneous light. Up to four of these detector heads can be used with a single unit.

The sensitivity is such that objects with a minimum width of 0·01 in can be detected at any position along a 4 ft beam. At 20 ft the minimum width of object is 0·025 in. It is claimed that the use of transistors ensures reliability and that apart from periodic lens cleaning the unit will function for long periods without maintenance. Normal temperature changes do not affect the performance and the equipment will function satisfactorily in ambient temperatures up to 60° C. *Cableform Limited, Romiley, Cheshire.*

CIRCUIT TESTER

Continuity and Leakage

NOW available is an automatic tester capable of handling up to 150 circuits or, with additional units, up to 450 circuits.

The model CHA-1001 has adjustable rates of testing from 1 circuit per minute to 10 circuits per second. Checks are made for continuity and for high potential leakage resistance. The speed and sequence of the tests are selected before the start, and stepping switches synchronised with a light bank automatically step through the test positions until a faulty circuit is encountered. Stepping is then stopped and a red light and buzzer indicate the discovery of a high voltage breakdown, leakage, or a direct short in the high potential test, or a high circuit resistance in the continuity test.

It is also possible to step through the circuits using a push button for individual checks. Programming buttons can be used to delete common circuits from the high potential test and an open test position is provided to enable a change in parameters to be made during continuity test sequence.

High potential test voltage is 0 to 2,100V dc, and continuity test current is rated at 2A at 0·1 ohms. Operational parameters for continuity are 0·1 ohm to 1,000 ohms minimum and for leakage tests from 1 megohm to 200 megohms minimum. Operation is from 115V supply, the detector supply being zener regulated. The cabinet version measures 21¾ in by 22¾ in by 12 in. *A. W. Haydon Company, Culver City, Calif., USA.*

DEW POINT METER

Operates down to −150°C

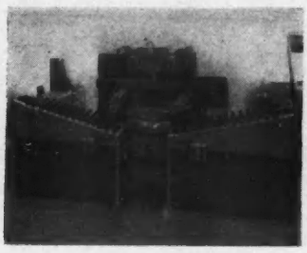
A NEW dew point measuring unit is now available for use in air and gas lines.

Claims for it are that it is simple and robust, needs no attention, and no gas has been found too dry for measurement. A standard hygrometer sensing head is inserted in the body which has connections for the pipe line, screwed for ¾ in BSP. Overall height is 12 in and the diameter of the main body is 2¾ in. A small flow of gas passes through the unit.

A range of elements is available to cover temperatures and humidities from − 150° C to +130° C at 80 per cent rh. Response times are 66 per cent of final value in 1 minute with a dew point change from − 50° C to −100° C, and stability is within 1° C over one month. The sensitivity is to 1° C for indicating instruments and to 2° C for recorders. Operation is not normally recommended at pressures above 5 lb per sq. in over ambient. *Shaw Moisture Meters, Rawson Road, Westgate, Bradford, Yorkshire.*

AUTOMATIC LOADER

For Gear Shaving Machine



The illustration shows an automatic loader that has been developed for a Red Ring gear shaving machine.

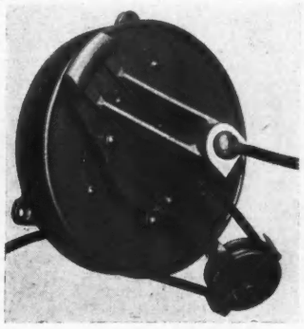
The part being loaded is the camshaft of an automobile engine and the set-up forms part of a production line. The inclination of the loaders is to accommodate the height of the shaver to that of the rest of the line. The action is fully automatic though the shafts can be fed to the conveyors by hand if desired.

Loader and unloader are similar, each having a chain conveyor which is sequence operated from limit switches. The feed is from left to right. A camshaft placed on the conveyor rest depresses the detector switch and the conveyor automatically indexes forward to bring the shaft into position for loading. The conveyor has a reciprocal motion and indexes back between cycles to keep the stations always full. This prevents gaps occurring which would upset the sequence of operations. Indexing is by a Geneva mechanism driven from a braked motor.

The loading and unloading arms are hydraulically operated from an independent system. The presence of a shaft in the loading position causes the loading arm to lower and the fingers grip the shaft; the head lifts and the fingers swing upwards. As soon as the appropriate point in the shaving cycle is reached, the shaft is turned inwards and held in position while the two centres come into grip it. The fingers then release the shaft and return to the initial position ready to pick up the next. The unloading action is precisely similar. *Precision Gear Machines and Tools Limited, Red Ring Works, Bodmin Road, Wyken, Coventry.*

AUTOMATIC CABLE REELER

No Slip Rings



Primarily designed for use as an inexpensive unit for light flexible cables, the automatic reeler illustrated has many uses in workshops.

The standard Metool units are large enough to accomodate up to 25 ft of 4-core 40/0076 flexible cable on the drum or alternatively up to 30 ft of 3-core 23/0076 cable. The cable passes unbroken from the mains through the winding drum to the equipment in use and this entire absence of slip rings and brush gear means that the resistance and impedance remain constant at all times however much cable may have been unrolled from the drum.

The reeler is therefore suitable for use in telephone circuits as it does not introduce any noise or interference, and for such other applications as thermocouples and strain gauges, which require constant conditions for satisfactory operation.

The drum on which the cable is laid remains stationary and the reeling is carried out by the rotating arm on which is the guide pulley. Drawing off the cable rotates this arm against a clock type spring, which, on release, rewinds the cable immediately. Apart from the good electrical properties resulting from the absence of slip rings and brushgear, the design allows an inexpensive construction so that the reeler can be economically used with hand lamps, portable tools or industrial vacuum cleaners. *Metropolitan Tool and Products Limited, 21 Victoria Street, Nottingham.*

FLAME CONTROLLER

Up to Six Heads Simultaneously

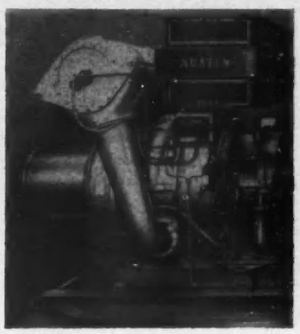
Series 704 flame controllers can be supplied for monitoring up to six flames at once.

The units are fully transistorised and have plug-in circuitry with an ac-coupled amplifier. They can be used with gas or oil fired burners and will discriminate between flame and flame radiation; the latter does not affect them. Each flame is controlled by a lead sulphide cell and a transistor amplifier which is sensitive to the modulated component in the flame radiation. The presence of the flame is indicated by an output signal from the transistor amplifier which in turn switches on a silicon transistor.

The circuitry of the units is such that the pilot relay, which interlocks with the flame relay and the safe start relay, cannot be energised until all the transistors are switched to the flame-on condition. When switched on the internal main connection is delayed for a prepurge period from 30 to 120 sec, after which an ignition light comes on. The starting button can then be pressed. When all the pilot burners light, the relay for the main valve is energised. *Ether Limited, Caxton Way, Stevenage, Hertfordshire.*

INDUSTRIAL GAS-TURBINE

250 bhp



A new 250 hp power gas-turbine is specifically designed for industrial use.

The unit can be supplied alone or coupled to an alternator or a pump. It is a single shaft machine in which the turbine rotor drives the centrifugal compressor at a speed of 29,000 rpm to give a pressure ratio of 3·5 to 1. The power is taken from the rotor assembly through a two step layshaft reduction train using double helical gears. The output speed is reduced to 1,500 rpm for 50 cycle alternators, but other ratios can be supplied.

Cheap fuels such as methane and by-product fuels increase the range of usefulness, and the relatively high cycle temperature of 800° C permits a high overall thermal efficiency when it is possible to utilise the exhaust heat.

The impeller and separate guide vanes are machined from aluminiuim alloy forgings and shrunk on the shaft. A diffuser of aerofoil vanes is used. The turbine is axial flow with two stages, blades and discs being of Nimonic 90. The fuel system and combustion are made largely in aluminium. Starting is automatic, initiated by push button. Pressure lubrication is used. A silencer can be mounted on the air intake as well as on the exhaust. The basic unit measures 37 in long by 35 in wide and 51 in high for a weight of 900 lb—about 3·6 lb per horse power. *Austin Motor Company Limited, Longbridge, Birmingham.*

CONTROL RELAY

Saves Panel Space

Designed primarily for the machine tool industry, the BF relay occupies very little space.

The unit measures only 3¼ in high by 1 11/16 in wide. It is available in any combination of normally open or normally closed contacts from two to eight poles with maximum of four normally closed. The rated full load current is 6A at 300V ac. The relays can be fitted direct to the panel and the terminals are all accessible from the front.

Special features include hardened magnet and armature pole faces; very short operating stroke; lightweight operating parts; silver alloy contacts that have a slight wipe on mating, for prolonged continuity; and kickout springs for positive action in opening, making the movement independent of gravity. The operating time on pickup is from 12·5 to 18 milliseconds and on dropout from 6·25 to 12·5 milliseconds.

It is claimed for the design that it occupies 50 per cent less space than most types now on the market, thereby greatly reducing the size of the control panel required. In the case of an automobile transfer line, a saving of 40 sq. ft of floor space was obtained, the panel being reduced from 35 ft long to 20 ft. *Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania, USA.*

OPTICAL SQUARE

For Large Surfaces

Reference planes can be set to within 1 sec of arc and 0·0005 in of displacement using a sweep optical square.

The instrument basically consists of a micro-alignment telescope mounted vertically with a right-angle prism head at the bottom. The telescope is rotated to sight on three datum targets and the feet adjusted till the micrometer readings are the same on all. A fourth target is then placed at each check point, the prism box rotated to bear on it and the reading taken. This reading is then a direct measure of the flatness errors with respect to the reference plane set up by the three datum targets. Readings are taken in units of 0·001 in with a total measuring range of ± 0·05 in.

The pattern of the target is a series of bars of successively reduced width, the narrowest for use at short range and the widest at long range. A recent and rather unusual application was checking a television studio floor *Taylor, Taylor and Hobson, Stoughton Street, Leicester.*

Electrical Engineers Exhibition

Earls Court, London 21-25 March

THE tenth Electrical Engineers Exhibition which opened at Earls Court on Tuesday last has communications for its theme. It embraces not only radio and telephones (there is a complete electronic exchange) but also cables and railways. One of the new electromagnetically operated level-crossing barriers is shown alongside a section of track. Control is from relays energised by the approach of a train so that the barriers will not need the presence of a crossing keeper.

Examples of things to come are the electroluminescent panels on the stand of Atlas Lighting. These are more unusual in being ceramic on metal instead of phosphor on glass and it is claimed that they are more robust and have an increased brilliance. Using a supply at 240 V 2,000 cycles, the emission is 4 ft lamberts. The backing is a steel sheet (forming one electrode) on which is a layer of vitreous enamel containing the phosphorus, fired at high temperatures. The second electrode is a layer of transparent conducting tin oxide with a protective cover glaze.

By contrast, examples of the past are the historical exhibits on the Pinchin Johnson stand where the history of electric motors and generators is portrayed. One item is an early compound machine made by Col. Crompton in 1883. Alongside are prototypes of machines now being developed using new principles. In addition to the items on display given below, others were described in ENGINEERING for 24 February.

LINE FAULT LOCATOR

Pulse Reflection

A FAULT locator is now available that will pinpoint arcing faults and ice build-up on transmission lines.

The instrument operates on the pulse reflection principle analogous to radar. The transmitted signal is generated in the locator in the form of 400 V peak to peak 5 microsecond pulses at a mean frequency of 1,000 kc/s and spaced at about 5 milliseconds.

The pulses are coupled to the line and are transmitted along its entire length. All discontinuities cause a reflection, small in the case of towers, or large as in the case of an arcing fault. The reflected pulses are received by the locator and displayed on a cathode ray tube for either visual or automatic photographic record.

Although specifically developed for use on 132 kV and 275 kV lines the locator is also suitable for other voltages. It can be used in manned or unmanned substations and works from the normal battery supply. *Ferranti Limited, Hollinwood, Lancashire.*

SEQUENCE SELECTOR

For Programme Control

UP TO ten circuits can be switched on or off in a predetermined sequence by a unit now available.

The sequence can be spread over a period of time that can be varied by the frequency of the input pulses. Provision is made for up to a nominal 10 minute sequence derived from a mains driven synchronous motor. The total sequence time required is set up in minutes and seconds by means of the selector switches. The reset button is depressed, setting the total sequence time on the indicators.

The output selection takes the form of selector switches and motor sockets. There are five 10 second banks of sockets which can be positioned in any part of the sequence. All banks can be switched to give continuous coverage from 0 to 50 seconds for short period tests where outputs are operated many times in sequence. Typical application includes the testing of electronic equipment where selected inputs are required in sequence. *Elliott Brothers (London) Limited, Century Works, Lewisham, London, SE13.*

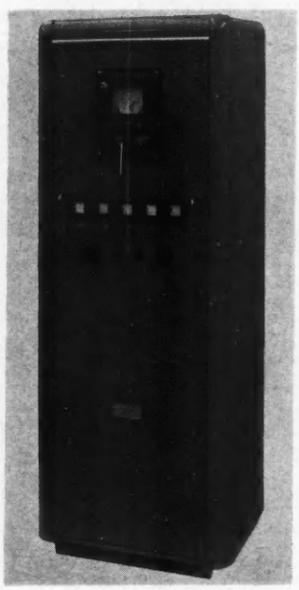
POWER FACTOR REGULATOR

Induction Heaters

CORRECTIONS can be made automatically to the power factor in high frequency induction plants by a new controller.

The instrument will compensate for changes in power factor on supplies ranging from 500 cycles to 10,000 cycles. It provides a method by which the magnitude of the out-of-phase component is measured and initiates correction in pre-selected steps. The time interval between each step may be selected by means of a switch on the unit. The standard equipment will control up to six capacitors in 24 combinations.

The unit is supplied in the form of a console with provisions for direct indication of power factor by means of a centre zero moving coil instrument. The maximum permissible deviation from unity power factor is determined by the presetting of the two limit contacts of the instrument. In event of a shut-down all capacitors are taken out of circuit. *Londex Limited, Anerley Works, Anerley Road, London, SE20.*



OIL CIRCUIT BREAKER

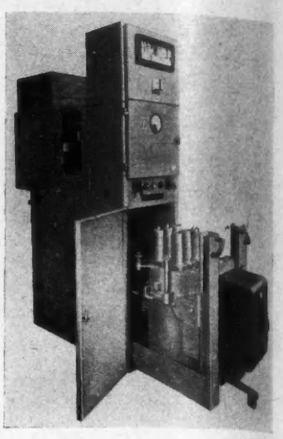
For 11 kV Lines

A NEW addition to the Q class of switch gear is the air insulated unit type QA500 with integral earthing.

The single break oil circuit breaker is rated for 250 MVA at 6·6 kV and for 350 MVA at 11 kV. It is fitted with removable bushings and has self compensated arc chambers. The arc gases are ventilated outside the equipment at the rear. The breaker is vertically isolated and can be withdrawn from the housing.

The busbars are insulated with pvc tubing and have standard ratings of 600 to 1,600 A. Current transformers and voltage transformers can be fitted, the latter being isolated by swinging the unit upwards. High voltage fuses are included within the leg insulators. A large instrument and relay panel forms part of the housing, and if required additional relay accommodation is provided by a second panel.

The three poles of the breakers are contained in a single round tank and the fixed contact fingers are spring loaded. The single break design permits a very simple mechanism. Operation is by hand, manual/spring, spring, or solenoid as required. Each type is trip free and can be fitted with a number of automatic tripping mechanisms. *Associated Electrical Industries (Manchester) Limited, Trafford Park, Manchester 17.*



PROTECTIVE RELAY

Overload and Single Phasing

PROTECTION against overload and single phasing is now given in a single instrument.

Type 8T130 covers the current range from 0·4 to 50A. The case measures only 3¼ in by 3⅜ in by 2⅛ in and the instrument snaps into the fixing channel. The relay terminals are the clamp type and take cables up to 19/064 size.

The tripping mechanism is operated by bi-metal strips which are actuated by heaters. A calibrated dial allows six settings from 100 to 150 per cent of the rating for the heaters in use. Single phase protection is inherent and is independent of the dial setting. Automatic compensation for variations in ambient temperature is included. Either hand reset or self reset can be selected.

The heaters are retained by two captive screws and can be changed from the front without removing the relay. Three heaters of the required rating are supplied in the standard model. *E. N. Bray Limited, Control Gear Works, Britannia Road, Waltham Cross, Hertfordshire.*

INFRA-RED HEATERS

One, Two or Three Elements

SOME new industrial infra-red heaters now available can have either one, two or three elements in a common spine.

Each fixed focus reflector assembly is independently adjustable in relation to the spine so that the heat distribution can be arranged to suit requirements. Interchangeable 1 kW or 1½ kW metal sheathed elements are used, the maximum loading thus being 4½ kW with the three element assembly. The heaters are strong but light in construction. The heavy gauge polished aluminium reflectors can be removed simply by withdrawing split pins. This makes for simple cleaning and maintenance.

The spine is finished in light hammertone bronze and may be suspended by conduit or chain. The overall length of the heaters is 49½ in. Light supplementary chains are provided to allow the heaters to be suspended off-balance so that the required direction of radiation can be achieved. *E. K. Cole Limited, Southend-on-Sea, Essex.*

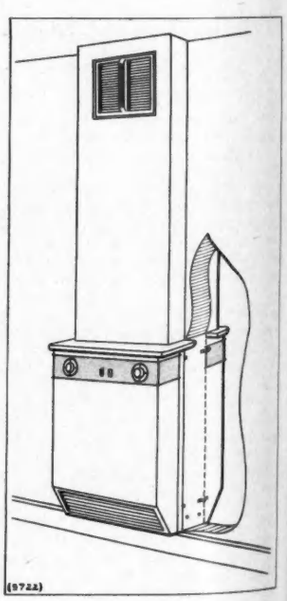
HEATER

For One or Two Rooms

TWO rooms can be heated either together or separately by an electric heater fitting in the party wall.

The unit contains electric elements rated up to 4·5 kW, with a switch to 1·5 kW, and a low speed fan. Air is drawn in from the grille in the top of the duct work and expelled at the bottom just above the skirting board. The inlet grille should be near the ceiling and not less than 6 ft from the floor.

Adjustable air vanes in the duct can be set to direct the flow either into both rooms or all into one room as required. In the former case the flow is 230 cfm and in the latter 160 cfm. The fan runs at 1,000 rpm and can be used independently of the heater so that cool air can be circulated in summer. It is resiliently mounted and very quiet. The power unit requires a space of 30 in by 18 in by 12 in front to back and the ducting normally projects about 4 in from the wall. Thermostat control is included. *General Electric Company Limited, Kingsway, London, WC2.*



Wise Investment

Sixty-six civilian and military reactors were under active design or construction last year in the United States. The total estimated cost was $1,328 million (£474 million), this figure excluding the reactors for propulsion of naval vessels (with the exception of NS Savannah), aircraft and space reactor work. The estimates showed an increase of $96 million over the figures for the previous fiscal year. The increasing slopes of the graphs in Figs. 1 and 2 illustrate the prosperity of nuclear power, and indicate the eventual role that it will play as a power producer and in the expanding use of radioisotopes for peaceful purposes.

Results of Experience

During the fiscal year of 1960 fifteen new reactors and one reactor modification were begun. The Federal Government, chiefly the United States Atomic Energy Commission, was the largest investor in the projects. About one-half of the Commission's costs for the civilian power prototypes and experiments is for the research and development into the system. On the side of the utility about 80 per cent of electric costs are for plant and equipment. In carrying forward many of the reactor projects the nuclear industry has reached a stage where it now can follow the construction pattern developed over the years in the conventional power field. Previously, industrial firms, educational institutions and nuclear consultants have played the principal role in the construction of civilian power reactors because of their experience gained in research and development work. In the pattern now developing (apart from the construction of new prototypes), architect-engineers are responsible for the overall design, the broad parameters for major equipment, and the evaluation of equipment offered by competitive suppliers. Manufacturers design and furnish integrated reactor systems and guarantee performance of the systems.

Civilian Nuclear Power Programme

The graph in Fig. 1 shows the growth of electricity production by nuclear power in the United States. During the last year there was an increase of 290 MW over the previous year. As more operating and cost experience is gained, reactor technology will advance. For example, within the past years the costs of naval reactor cores has decreased by about 40 per cent and at the same time the useful life of the cores has increased about 70 per cent.

Pressurised Water Reactors

Shippingport Atomic Power Station

The Shippingport Station is the first major nuclear power electrical generating plant in the United States. The 60 MW(e) reactor first achieved criticality and began supplying electricity in December, 1957. Since this date various tests have provided a deeper knowledge of technology, operation and cost data. During the past year higher burnups in the uranium oxide fuel elements have been obtained than in any other reactor; and tests have confirmed the advantages of the seed and blanket core concept which requires the minimum investment in uranium 235 and gives the maximum power obtainable from natural uranium.

The first seed, which produced 388,500 MWh, was replaced in March last year and the second went critical in April. Since May the plant has been operated for the majority of the time at full power in order to realise information of the lifetime capabilities of the uranium dioxide blanket. The cumulative load factor for the second seed has been twice as great as the first. The average burnup in the blanket is 3,200 MWD per ton, but the peak burnup is about 14,000 MWD per ton. Providing the fuel elements continue satisfactorily, a third seed will be placed in the core in the middle of this year.

Design and planning for a second core is in progress and is scheduled for completion early in 1962. It will have a design energy output five and a half times that of the first core with a lifetime of 20,000 full-power hours; and it will use oxide fuel plates in the seed and the blanket with fewer hafnium control rods. To dissipate the higher power a 50 MW heat sink is to be installed.

Yankee Atomic Electric Company Reactor

The Yankee Atomic plant was the first of the USAEC's Power Demonstration Reactor Programme, and it has recently reached the design power level of the first core (110 MW), but it is expected to be increased to 136 MW(e). The

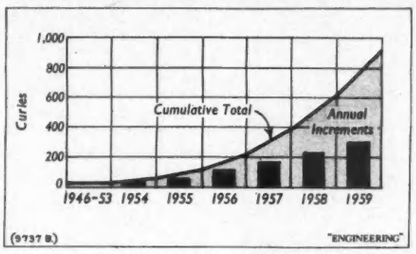


Fig. 1 Growth of the United States electrical production by nuclear power.

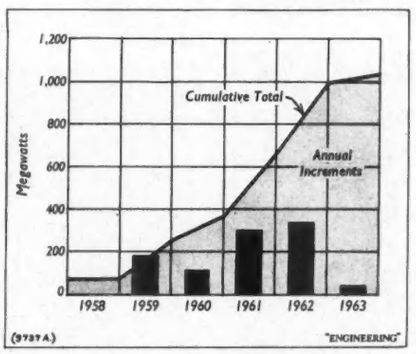


Fig. 2 The use of radioisotopes in the United States continues to increase.

reactor differs from the others of its type by using a stainless steel clad, slightly enriched uranium dioxide core.

Consolidated Edison Thorium Reactor

The privately financed 255 MW(e) plant of the Consolidated Edison Company continues under construction and is scheduled to go critical in September, 1961. The reactor has a nuclear capacity of 151 MW and an oil fired superheater to increase the capacity by 104 MW. The fuel is a mixture of thorium and uranium 235.

Other reactors of this type include the Saxton Nuclear Experimental Reactor and the 360 MW reactor of the Southern Californian Plant of the Edison Company.

Boiling Water Reactors

Experimental Boiling Water Reactor (EBWR)

The EBWR at Argonne National Laboratory was shut down in July, 1959, for modifications to increase the plant thermal capacity from 20 MW to 100 MW. Due to leaks being detected in two primary reboilers, which are used for the additional heat removal, full power operation has been delayed until this year. Operation at the higher power level will permit tests to explore the stability of small natural-circulation boiling reactors with cores of greater power densities than have been used previously. The original turbine capacity, 5 MW(e), will not be increased, and the excess energy will be dissipated through heat exchangers.

Elk River Reactor

Criticality is expected at Elk River within two months; it has been delayed because of cracks detected in four 16 in reactor vessel nozzles, and further difficulties have been experienced in the fabrication of the core. The reactor will provide performance and cost data on a small plant using an indirect natural-circulation boiling-water reactor, coupled with a separate coal-fired superheater. The reactor is being built by the USAEC in cooperation with the Rural Cooperative Power Association: the Commission owns and constructs the reactor while the utility supplies the site and the conventional turbogenerator equipment, operates the reactor and purchases the steam.

Vallecitos Boiling Water Reactor

The privately owned 5 MW(e) reactor experiment of the General Electric Company was returned to operation in September of last year after being shut down for a year for modifications; these included installing new circulating water pumps and piping, and a new core structure to permit different fuel arrangements. The reactor was initially constructed and operated to develop the fuel and reactor design for the Dresden Power Station. It is now obtaining data on high power density cores.

Dresden Nuclear Power Station

The 180 MW(e) station at Dresden became critical in October, 1959, and went on to full power in June, 1960. Although control rod difficulties had occurred during the low power experiments these were rectified, but on 15 November, 1960, one of the control rods separated from its drive. Investigation showed that the drive tube, to which the control rod is attached, had severed. Also a second drive tube showed evidence of cracking. It was decided to remove the whole core and examine all drive tubes. There was no connection between this trouble and the difficulties experienced earlier. A public hearing for the resumption of operation is to take place at the end of this month.

Other reactors of this type include the Consumers Power Company Reactor at Big Rock Point, Michigan, scheduled to go critical at the end of 1962; the Improved Cycle Boiling Water Reactor (300 MW) to be built in Haskell Canyon as part of the Power Demonstration Reactor Programme and planned for completion in 1964; and the privately owned 48·5 MW(e) Humbolt Bay Power Plant scheduled to reach design power by the end of 1962.

Nuclear Superheat Reactors

Borax 5

Construction of Borax 5, the fifth in a series of boiling reactor experiments carried out by the Argonne National Laboratory, is nearing completion at the National Reactor Testing Station. It will operate initially with a limited number of test channels producing superheated steam and by the middle of this year should attain the design power of 40 MW(th) with the full boiling-superheating core.

Other reactor projects on this system are the 62 MW(e) Pathfinder Atomic Power Plant scheduled to go critical in June, 1962; and the 16·3 MW(e) Boiling Nuclear Superheat Reactor (Bonus) at Puerto Rico, due for completion in December, 1962 (Atomic Review, 13 Jan. '61).

Organic Cooled Reactors

Organic Moderated Reactor Experiment (OMRE)

Omre has now been in operation for three years, and has used two core loadings. The primary object is to demonstrate the feasibility of the system. The third core was loaded in September last year. Examination of the second core fuel elements verified the suspected surface

fouling of certain fuel elements. Analysis of the material deposited on the fuel surfaces showed that the fouling material contained a large percentage of iron oxide and iron carbide in addition to the radiation decomposed organics. It is suspected that the fouling is the result of iron particles present in the organic coolant as a contaminant. The mechanism of fouling is believed to result from electrostatic precipitation of the particles and polymerisation of the organic (which surrounds the particles), caused by intense radiation fields at the surface of the fuel plate. The special test elements in the second core loading, similar to those to be used in the Piqua reactor (Fig. 3), showed only small deposits. The OMRE primary loop has been modified to provide tests of devices for the removal of inorganic particulate matter. The third core will have the iron particulate removed from the coolant system. Later in the year the reactor will be modified to provide more adequate fuel handling, fuel storage, and process equipment facilities, which will extend the usefulness of the reactor by at least another five years. The schedule will include a year's operation on the low enriched metallic fuel similar to the Piqua reactor, and one year on uranium fuel.

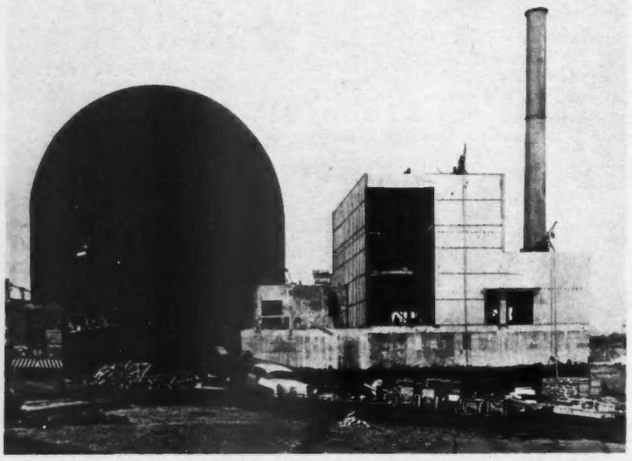


Fig. 3 The 11·4 MW organic moderated and cooled reactor at Piqua, Ohio, which will be operated by a municipal utility. The right-hand building will contain process equipment, a control room and offices. The station will be completed this summer.

Prototype Organic Cooled Reactor

Last December the Commission invited expressions of interest from cooperatively and publicly owned utilities in a reactor of 50 MW(e) capacity using uranium oxide and aluminium powder metallurgy for cladding. The prototype for a plant of 300 MW(e) will investigate the low capital and maintenance costs associated with a plant using low pressure coolant whose corrosive characteristics will allow the use of low cost materials; the low coolant replacement costs and acceptable heat transfer characteristics of the polyphenyl organics under forced convection and nucleate boiling; and the reduced fuel cycle costs with high burn-up fuel.

Fast Sodium Cooled Reactors

Experimental Breeder Reactor No. 1

The EBR-1 was completed in 1951 and has been operating on the Mark III core since late 1957. It will be shutting down shortly to install a plutonium alloy core. Experiments on the Mark III core have shown that by a tight configuration of the core, the prompt positive power coefficient of reactivity which caused the partial melt-down of the Mark II core could be eliminated.

EBR-2

Construction of the EBR-2 is almost complete and design power operation of 16·5 MW(e) is scheduled for the summer. The first core is using uranium 235, and the second core may use plutonium. The primary object of the reactor is to demonstrate the feasibility of recycling fuel using pyrometallurgical methods for reprocessing. Fig. 4 shows the delivery of the pressure vessel which is now in position. (Atomic Review 9 Dec. '60).

The Enrico Fermi 94 MW(e) is about a year behind schedule because of construction delays and the redesign of fuel elements but it should go critical this summer.

Thermal Sodium Cooled Reactors

Hallam Nuclear Power Facility

After the incident with the Sodium Reactor Experiment (SRE) and the resultant failure of the fuel cladding and fuel elements (Atomic Review, 10 March '61), a careful review was made of the design of the Hallam project, and certain changes have been made. The station is about 60 per cent completed and is scheduled for operation early in 1962. The initial fuel loading will be uranium-molybdenum alloy, but with the present development work on uranium carbide fuel may prove satisfactory for the second core loading.

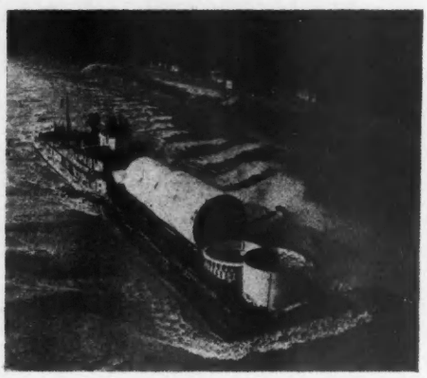


Fig. 4 Transporting the reactor vessel for the Hallam Project last year. In a later part of the journey by road it fell off the trailer, and rolled 150 yd into a field, but sustained no serious damage.

Gas Cooled Reactors

When finished in October, 1962, the 22·3 MW(e) Experimental Gas Cooled Reactor (EGCR) will be the first civilian gas cooled nuclear power plant in the United States. Design changes made late last year deferred the installation of some of the test loops until some operating experience had been obtained.

Research and development continues on the High Temperature Gas Cooled Reactor proposed by the Philadelphia Electric Company and the General Dynamics Corporation under the Power Demonstration Reactor Programme (Atomic Review 23 Sept. '60). The original plan for the first core loading of metal clad fuel elements has been revised and now graphite matrix elements are to be used, which had originally been planned for the subsequent cores.

Heavy Water Reactors

The 17 MW(e) Carolinas Virginia Tube Reactor is now about 15 per cent complete. The reactor replaces the conventional large pressure vessel by using 42 pressure tubes installed in a low pressure tank.

Construction of the Heavy Water Components Test Reactor at Savannah River was 45 per cent complete by the end of last year. Operation is expected to begin at the end of this year. The 61 MW(th) reactor is to be used as a test facility for the heavy water moderated system.

Other Systems

The status of the Aqueous Homogeneous Reactor (HRE-2) was given in Atomic Review, 3 March '61, describing the action taken on the discovery of holes in the blanket region of the core.

Work will begin in the Spring at Oak Ridge on the proposed 10 MW(th) Molten Salt Reactor (Atomic Review, 18 Nov. '60).

Other concepts that have survived preliminary evaluation are the liquid fluidised bed, advanced epithermal thorium (Atomic Review, 11 Nov. '60) and pebble bed gas cooled reactor (Atomic Review, 2 Sept. '60).

Concepts in the earlier stages of development include the mercury cooled fast reactor; the variable moderator reactor; the super-critical water reactor and the spectral shift reactor (Atomic Review 16 Sept. '60).

Notes and News

Reactor Course for Senior Executives

Harwell Reactor School will hold the next two-week course of senior technical executives from 8 to 19 May. The first week will be spent at the Reactor School and the second at Durley Hall, Bournemouth. The course is planned to give senior industrialists who have a technical background an overall appreciation of the problems of reactor technology. The lectures will cover the physical, metallurgical and engineering problems involved in the design of power reactors, and the chemical problems of fuel and effluent processing. In addition there will be lectures on the present nuclear power programme and on the organisation of the UKAEA and its relation with industry. The fee for the course is 50 guineas, excluding accommodation; more details may be obtained from the Manager of the Reactor School.

Fuel Element Course at Imperial College

A course of ten lectures on the industrial problems of reactor fuel element technology will be given at Imperial College on Thursdays, May 4, 11 and 18, 1961. Eight lectures will be given by members of the Atomic Energy Authority and two will be given the head of the Fuel Element Section of the Commissariat à l'Energie Atomique, Saclay.

Recent Appointments

Dr. Pierre Louis Balligand will succeed Dr. Hubert de Laboulaye as Deputy Director General in charge of the Department of Technical Operations of the International Atomic Energy Agency. Dr. Balligand is head of the division of large research reactors of the French Commissariat á l'Energie Atomique. The division was inaugurated to supervise the operation of the EL 2 and EL 3, and will also include the operation of the reactor Pegase at the new centre, Cadarache. Dr. de Laboulaye will leave the Agency at the end of this month and will return to the French Commissariat.

Captain H. A. Kidd has been appointed to command the Admiralty reactor establishment at Dounreay, Caithness. He will be in charge of the construction of the land-based submarine to be equipped with a nuclear reactor.

Companies

Stable Production a Key to Exports

After a year in which consolidated net profit fell by almost half from the record level of 1959, HOOVER are meeting the problems of 1961 with new additions to their range of products and the cautionary belief that it will probably take a general improvement in economic conditions to relieve the present state of reduced output from the domestic appliances industry.

When 1960 began Hoover were very active, keeping up a high rate of sales for the first quarter of the year. There were already some indications of a levelling off in the surge of demand let loose by the 1958 removal of credit restrictions. While the company were carrying through a planned reduction of output, the Government suddenly reimposed hire purchase controls at the end of April, throwing up a situation which had to be met with immediate further cuts in output, leading to steeply rising production costs, strained labour relations and inevitable inefficiency.

Compared with the last three quarters of 1959 the home sales declined by a third. The company's annual review quotes as evidence of the "virility" of the organisation that they were still able to produce a consolidated profit of £6,372,783, the second highest in the history of the company. In 1959 the consolidated net profit had been £11,135,225.

Attacking a Fallacy

Two factors helped to keep the results up. One was the contribution made by the profits of the first quarter. The second was the continuous policy of ploughing back earnings into the development of export outlets and the establishment of overseas subsidiaries. During 1960, as the result of these efforts, exports rose by 37 per cent, to some degree offsetting the sharp fall in home demand. Hoover exported 75 per cent of all the washing machines and vacuum cleaners leaving the United Kingdom last year.

The company strenuously urge on the Government that continued export success depends on the cost advantages which can only be obtained from a stable production flow. There is a strong possibility that if the home market goes on being disrupted by frequent changes in hire purchase controls the present export position will be lost due to inability to maintain price competitiveness.

The belief that a restricted home demand forces manufacturers to sell overseas is attacked by the Hoover annual review as erroneous and dangerous. Unremitting effort over a long period, highly competitive prices and a constant process of product evolution in line with the requirements of each market—these are the ingredients of the Hoover recipe for export success and they do not include Government interference with orderly and well planned marketing at home.

From the buoyant home market of 1959 came the low unit costs which made possible reductions in export prices directly leading to the 18 per cent increase in the company's exports in 1959 and by 37 per cent last year. This would not have been possible if at times the needs of the overseas consumers had not been given precedence over the more immediately profitable home market.

The 1961 additions to the range of Hoover products include a fully automatic washing machine designed by the engineering division at the Perivale, Middlesex, headquarters, a new low priced cleaner and a redesigned version of the Hoovermatic equipped with thermostatic controls.

Delay at HQ

Preparing for future expansion in demand, the extension to the Merthyr Tydfil, South Wales, washing machine factory of 100,000 sq. ft has been completed and is the scene of the production of the automatic machine. At Cambuslang, Scotland, the 85,000 sq. ft building housing capacity for motors for the increased washing machine range is expected to be in use next month.

Only at Perivale has there been delay. The planning authority has refused consent for development regarded as essential by the company. An appeal has been made and it is hoped that this will be successful so that a start can be made to the work this year.

Among the overseas subsidiaries some advance in demand for domestic appliances is expected in France, though it is not likely to be great. Finland has enjoyed a strong upswing in economic activity and the overall sales of durable consumer goods has risen by 15 per cent. Hoover have a more than proportionate share of the market. In Australia sales were extremely successful, reaching new records in turnover and profit. The credit squeeze has now caught up with the Australian market and although predictions are difficult it is not likely that 1961 will produce the exceptional results of the past two years.

One of the most courageous actions Hoover have been fighting on the export front has been the break into the West German market, the most competitive in Europe, with the possible exception of Switzerland. After uphill work the first real break-through was seen to have been made with increasing acceptance of the Hoover Agitator Cleaner. In the past year sales of this cleaner have been doubled, despite the intense competition of low price German made suction cleaners.

A useful side effect of the success with agitator cleaners has been the readier acceptance of the company's washing machines and polishers.

Airborne Weather Radar Anglo-American Agreement

Airborne weather radar equipment designed and developed by EKCO ELECRONICS Limited, and E. K. COLE subsidiary, is to be made under licence in the United States by the WILCOX ELECTRIC Company, of Kansas City. The agreement between the companies gives Wilcox manufacturing and distributing rights for the next ten years.

Mr. Jay V. Wilcox, the president of the Wilcox company, commented on the signing of the agreement, "The Ekco design of equipment will be available in the United States for commercial airlines, private aircraft and the Government. The company's additional volume generated by the new lines should be at least one million dollars annually."

Ekco see the agreement as an opportunity to work together with Wilcox on new radar developments and as permitting a wide interchange of products on domestic and foreign airlines.

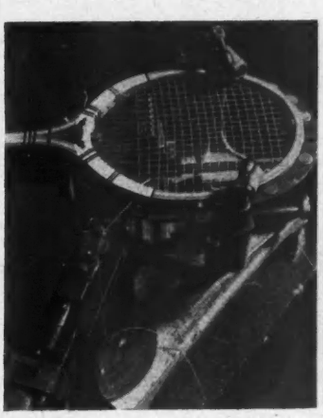
Engineering staff from Ekco Electronics will work with the Wilcox organisation to prepare for production of the radar equipment and in training personnel. Wilcox are currently engaged on a programme of expansion after acquiring substantial additional factory space.

The United States Federal Aviation Agency requires airborne weather radar on all commercial airlines. The Ekco equipment is able to locate large water droplet clouds within a 150 mile radius. It enables the pilot to discriminate between safe areas and areas of potential turbulence in cloud formations, determines the approximate height of cloud formations in relation to the aircraft and produces a scale plan view of the terrain ahead of the aircraft.

Keeping the Ball in Court

The DUNLOP SPORTS Company, selling to 150 countries, accounted for a quarter of all the exports of sports equipment by United Kingdom manufacturers last year. The final figure for the year's overseas trade was £4,958,000.

A threefold increase in the last ten years has been achieved, although Dunlop [now produce sports gear in



South 'Africa, the United States, New Zealand, France, Japan, Australia, India, Germany and Eire.

The best markets for Dunlop's golf and tennis equipment are the USA, South Africa, Germany, New Zealand, Canada, Malaya, Switzerland, Holland, Sweden, Indonesia and Italy and Venezuela.

Special forethought has to go into sports equipment for the export market just as much as more workaday equipment. Golf balls for desert courses are red and yellow (why only on desert links?). Tennis balls for sandy courts are red. For tennis at high altitudes, where normal balls would bound out of court, Dunlop provide low pressure balls.

Completed tennis racket frames are strung (inset) at the company's Waltham Abbey factory.

In its proportion of output sent abroad, the Dunlop Sports company compares well with many in other industries. The export percentages of its production are: table tennis bats and balls, 70 per cent; tennis balls, 65 per cent; tennis rackets and frames, 60 per cent; golf balls, 55 per cent. The proportion falls to only 35 per cent for the golf clubs themselves.

Sixty Years of Insulation

From a gas ring inside a biscuit tin heating moulds for micanite V-rings to the MICANITE AND INSULATORS Company's 2,500 kV surge generator in the new EHV test building is a very long way—it is in fact an indication of the distance travelled by the company of that name since it was founded, as the MICA INSULATOR Company, with a factory at Stansted, Essex, in 1901.

Early methods of manufacture may have been crude but there have been examples of some of the first rings being in continuous operation for 50 or more years, often without major overhaul.

The First World War brought an early wave of expansion, among the steps taken being the introduction of synthetic resin bonded laminates based on the phenol-formaldehyde reaction developed in the United States by Dr. Baekland.

In the 1920s M and I were making bushings up to ratings of 100 kV. Plug and socket bushings were made up to 33 kV for use in metal-clad switchgear which was becoming increasingly used in power distribution. By 1929 outdoor bushings of 132 kV were being produced for the first National Grid.

Under licence from the Society of Chemical Industry in Basle, M and I introduced in the 1930s an aniline-formaldehyde resin of value in high frequency applications which was superseded by plastics then being developed. A new cylinder winding machine installed at this time was able to produce "Paxolin" cylinders 100 in or more in length and up to 67 in diameter.

The years of the Second World War and immediately after brought another sustained burst of expansion. New uses for products were piled on heavy demands for all the former applications. "Paxolin" resin bonded laminates went into an endless variety of uses. Barrage balloon valves, aircraft panels and control details, aerial masts, flare chutes, petrol tanks and special types of bomb cases were on the long list of applications.

The M and I company BRITISH TEGO GLUEFILM Limited produced dry film adhesives to provide wood laminates. These went into propellers, the hulls of fast coastal vessels and into aircraft, notably the celebrated Mosquito.

The 1950's saw a considerable sweep forward in the construction of new power stations and in the production of electrical equipment, machinery, radios and appliances. All these needed insulation, from the high voltage bushings of transformers to the Micanite heating element of the domestic electric kettle.

The drive to greater power outputs and pressures has been steadily reflected in developments in M and I products. Electrical test facilities now include the 2,500 kV surge generator and gear for testing at voltages up to 750 kV at power frequency.

Among the new materials, the company believe that their Samicanite, which is manufactured from a mica paper, will rank with the introduction of Micanite more than 60 years ago in its importance to the electrical engineer.

Maximum Efficiency in Solvent Degreasing

Solvent degreasing can be a wasteful process both in materials and in time. An automatic packaged plant is highly efficient.

TRICHLORETHYLENE and perchlorethylene have been recognised for many years as being two of the most effective degreasants available to industry. They have proved of particular value in all kinds of engineering for removing from metal components everything from light machining oils to heavy grease coatings. Their effectiveness can vary, however, according to the means of application.

Dawson Brothers Limited of Gomersal, Leeds, have borne this latter fact in mind in the development of their range of automatic solvent degreasing plant. Their machines, which can be used with either trichlorethylene or perchlorethylene, provide a method of rendering all kinds of metal parts chemically clean and dry without the use of water, detergents or hot air drying. Machine operation is simple and speedy and the closely controlled treatment ensures that the parts are completely degreased and moisture free for any subsequent process such as painting or plating.

The application can be by the suspension of the parts in solvent vapour, or a combination of this and immersion in boiling solvent. For superfine immersion cleaning, a transducer unit can be incorporated to set up ultrasonic vibrations in the solvent. Machines can be supplied incorporating solvent spraying sections. The choice of which method to employ depends on the amount of grease, oil and solids on the parts being cleaned, and the processes they are to undergo after cleaning.

Solvent is consumed in direct proportion to the weight of the work and the Dawson machines are designed to ensure that consumption is kept to a minimum. Furthermore, the totally enclosed construction of the machines and the various safeguards incorporated in them ensure that loss of solvent to atmosphere is virtually eliminated.

As with most other industrial operations today, the Dawson solvent degreasing plant can be classified into two types—continuous operating, and batch operating. This article is concerned with the former.

CONTINUOUS DEGREASING

In the continuous operating plants, the parts being handled are taken through the degreasing process automatically in carriers attached to a moving conveyor. Special loading and unloading facilities and other automatic handling devices are frequently built into the machines to match up with existing handling arrangements already in use. Machines of this type are available incorporating solvent degreasing for use in conjunction with acid pickling, phosphate coating, bonderising and other pretreatment processes in any of a variety of combinations. Solvent spray sections can also be included in the plant.

The technical details given in this article describe standard continuous operation machines incorporating a double immersion and vapour degreasing treatment, but most of the information also applies to the single immersion vapour machines and machines for vapour degreasing only.

These machines are available for through or return operation as the diagram shows. With the through type, the parts are loaded by an operator at one end of the machine, and are carried through the treatment to be unloaded by a second operator at the other end. On the return type, the parts are loaded and unloaded at the same end of the machine by one operator.

The conveyor consists of two continuous chains fitted with evenly spaced carriers, which can be in the form of cylindrical carriers as shown on the diagram or hanging fittings. The conveyor is driven by an electric motor through a reduction gearbox. Power transmission is through chains and sprockets to provide positive movement of the conveyor chain. Tensioning devices are fitted at suitable points for easy adjustment when necessary.

Above a certain speed, the conveyor would tend to bring vapour above the cold strata with the consequential loss of solvent. This cannot happen in the Dawson machines as the conveyor never operates above the maximum speed for safety.

OPERATION

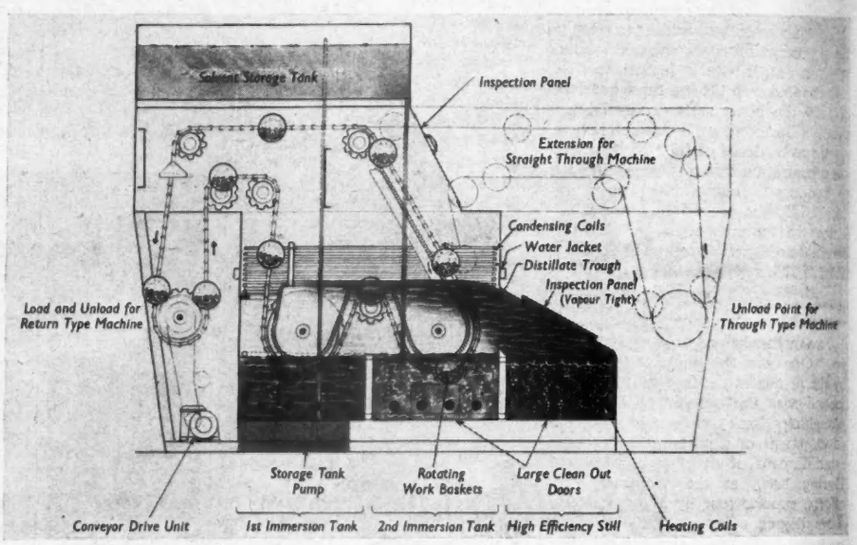
The operator loads the carrier or places a loaded carrier into position according to whether the machine operates on the fixed or detachable carrier method. He then presses the starter button which indexes the conveyor, and all the carriers attached to it, through one pitch, to bring forward a carrier of clean parts to the unloading position. This is emptied or removed and the next batch of soiled parts is loaded, and the cycle of loading operations continues, each time indexing the parts through a further stage of the cleaning process. An important feature of these machines is that the process time is under the control of a time clock, and thus the operator cannot advance the conveyor until the timed period is completed. This guarantees that the parts receive the full treatment which the machine was designed to give them.

The carriers first enter the vapour zone where degreasing commences as the vapour condenses on the parts as pure solvent. They then move into the first immersion tank where the boiling action and the natural degreasing action of the solvent removes the grease, oils and solids suspended on them. They then emerge from the liquid into the heavy vapour, where the cleaning action continues, before entering the second immersion tank of clean boiling solvent, which is being constantly refreshed by the entry of pure solvent flowing from the condensing coil. This immersion treatment thoroughly rinses the parts clean of all traces of soilage before they emerge and pass finally through the heavy solvent vapour. When they leave the vapour, the heat imparted during the treatment, combined with the volatile character of the solvent, enables them to dry quickly before they reach the unloading position.

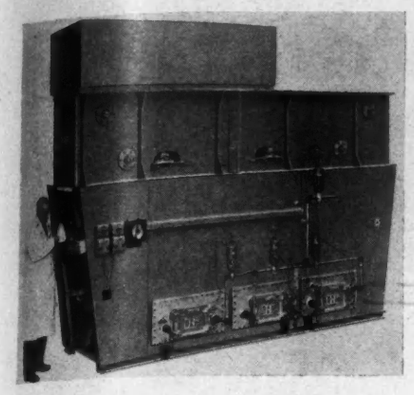
A notable feature of the machines from both an economical and a space-saving viewpoint is the continuous distillation system built integrally into them. This is a considerable improvement on other machines of this type where the still is a separate unit. This built-in system ensures the maximum recovery of vaporised solvent and, by a system of overflows, it weirs dirt and sludge from the immersion tanks into a still tank. The rising vapour from the boiling solvent in the two immersion tanks and in the still tank enshrouds the carriers and their contents and rises into contact with the condensing coil which converts it into liquid solvent. This falls into a trough and is returned through a water separator to the second immersion tank thus constantly replenishing and refreshing the solvent already there. From there, the solvent weirs over to the first immersion tank and the surface oil and scum on that tank flows into the still. Thus, the soilage collects in the still for easy removal at cleaning down times through the clean-out doors provided.

The condensing coil is copper tubing through which cold water is continually circulating and this, together with a water jacket surrounding the outside of the tank level with the coil and connected to the same cold water supply, provides a complete cold strata which condenses the vapour and allows none to escape to atmosphere. If for any reason, such as a failure in the water supply to the condensing system, the vapour should tend to rise above the desired level, a thermostat is fitted which automatically switches off the heating supply in the immersion and still tanks. An additional important safety feature is a thermostat fitted in the water outflow from the condensing coil. If the temperature of that water rises above the level for effective condensation of the vapour, then the thermostat operates a circuit which automatically increases the flow of water through the condensing coil system. This is a great improvement over other systems in that the flow of water is automatically adjusted to suit the work passing through the machine. For example, less vapour condenses on light parts than on heavy parts so that, where a variety of parts are bing handled, the amount of vapour rising to the condensing coils could vary considerably. This system ensures that only the minimum amount of water necessary for cooling is used, whereas on other machines where the flow of water through the coils is manually fixed to suit the lightest work handled, the water consumption is much higher than necessary.

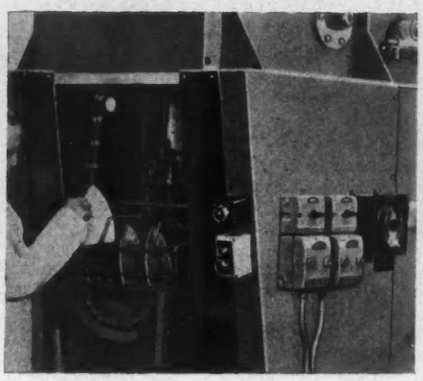
In addition to the vapour and water flow



This diagram shows how the automatic solvent degreasing machine works.



The double immersion/vapour degreasing machine.



A cylindrical carrier basket being loaded.

A typical hanging fitting.

thermostats described already, low level thermostats are fitted in the two immersion tanks and in the still tank. The purpose of these low level thermostats, and particularly of that in the still tank, is to cut off the heating medium if the solvent temperature should rise above 248° F (owing to accumulation of oil). Heating above this temperature will ultimately decompose some of the solvent and the acid formed will attack the plant. It is important, therefore, that these thermostats should always be covered with solvent and to facilitate this a float-type level indicator connected to the still tank shows, at a glance, the level of solvent.

These machines are a complete packaged construction, ready for immediate connection. All heating, water and electric lines are taken to a common connecting point.

Construction can be in stainless steel, or galvanised mild steel according to requirements. Dawson's state that they prefer to supply the conveyor chain in stainless steel but alternative materials can be supplied if required.

Easy access to the interior of the machine is provided by large and quickly removable doors on the sides of the tanks, and detachable panels in suitable positions on the outside of the machine. An important feature of machines for steam or high pressure hot water, is that the heating coils are mounted on easily removable plates bolted to the sides of the tanks. This enables the coils to be removed from outside without the need for personnel to enter the tanks. The clean-out doors are fitted into these removable plates.

Heating can be by steam as shown in the diagram or by high pressure hot water, or electricity.

The steam heated solvent degreasing plant is designed to operate at 30 lb per sq. in (dry saturated gauge), and pressure should be regulated accordingly, though machines can be supplied for lower pressures if necessary.

In the case of high pressure hot water, the manufacturers can provide the necessary control gear on learning details of the supply.

As the diagram shows, the machine can be fitted with a pure solvent storage tank. This tank, which is an extra, can be fitted at the top of the machine as shown, or at the side. It feeds the second immersion tank by gravity. A pump can be supplied for refilling the storage tank from floor level.

The frequency of the cleaning down periods vary according to the amount and nature of the work with which the machine has to cope. At cleaning down times, the distillation plant distills all the solvent in the tanks, and the pure solvent is carried from the trough beneath the condenser coil into a small tank integrally built into the machine and fitted with a magnetic float and pump. From there it is pumped into the main storage tank.

When this distillation process has reduced the depth of the solvent in the immersion and still tanks to the level of the heating coils, the supply to these is cut-off and auxiliary heating elements fitted on the under-side of the tanks come into operation. These elements enable all the remaining solvent to be distilled thus effecting complete recovery. The sludge deposits in the tanks are then easily removed through the clean-out doors.

Automatic Provender Mill

What is said to be Britain's first fully automatic medium sized provender mill, based on the cold press principle, has been installed by Pine and Son Limited of Maidstone to produce meal and pellets of the " Nitrovit " formulation. A complete Nitrovit range of around 50 different rations are being made. The Turner-Heesen plant is run by three men and will initially produce 4 tons of the smallest sized pellets or eight tons of meal per hour.

The outstanding features of the plant are the mixed grinding of the grain ingredients, the maturing bin and the presses, designed to produce pellets without steam. Normally, each type of grain is ground separately but mixed grinding saves space. The new plant occupies a ground area of only 625 sq. ft and it was designed to make use of existing bag and bulk raw material storage space.

The plant operates on the batch system. One man feeds the weighed ingredients into the plant —two indicator lights tell him when to introduce the ready ground protein meal and the whole grains.

The grain portion passes by elevator into a premixer. Mixed grain is then elevated into a grinder, and blown first into a cyclone and then into a new type of square aftermixer of Dutch design where the protein meal portion is ready waiting. Grinder, cyclone and aftermixer are all duplicated so that the flow of batches through the plant is uninterrupted—while one is being filled the other is emptying. The control of these processes is entirely automatic.

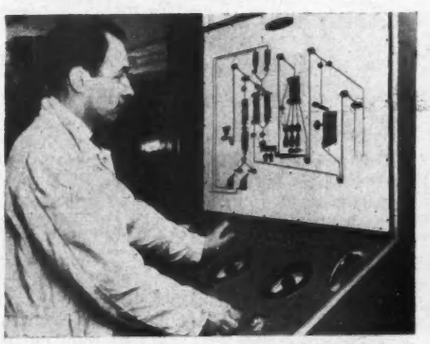
Molasses and fat supplied from two 60 gallon tanks are then added by a metering device. The molasses tank is electrically heated to 120° F and the fat is kept at 170° F. These containers are automatically topped up by two monopumps, from two 1,850 gallon bulk tanks maintained at 70° F.

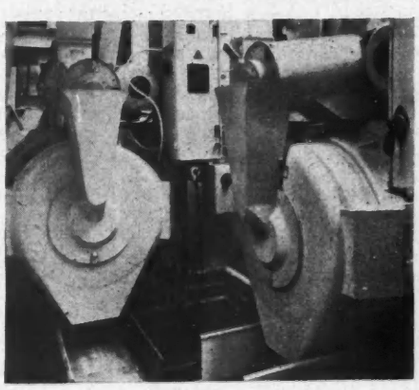
The enriched meal thus produced is elevated into an overhead 1 ton maturing bin to allow molasses and fat to become fully integrated with the meal. This bin has four outlets. Two lead into individual turbulators which add water to the meal for the pelleting process, another leads straight to the meal bagging off point, and the fourth is available for the addition of another press. From the turbulators the meal passes through two heavy duty presses, at 2 tons per hour, which cold press the material through a die into pellets. The presses are driven by 25 hp electric motors. Heat is generated by the pressure achieved during the process which drives out the water that was added previously. Each press incorporates one very large roller instead of the usual two or four.

After going through screening and cooling phases the pellets are ready for bagging-off or loading into bulk trucks. Stitching and weighing into ½ cwt bags is automatic.

The plant runs very quietly since the grinders are housed in a noiseproof fireproof and floodproof cell. All slides which control the flow of meal from bins are pneumatically powered and electrically controlled and are also fully automatic. Eleven magnets placed at strategic points in the plant extract metallic objects from the meal.

Of the three men operating the plant one, as already mentioned, feeds the plant, one looks after the discharge end of the plant and the third runs the control room.





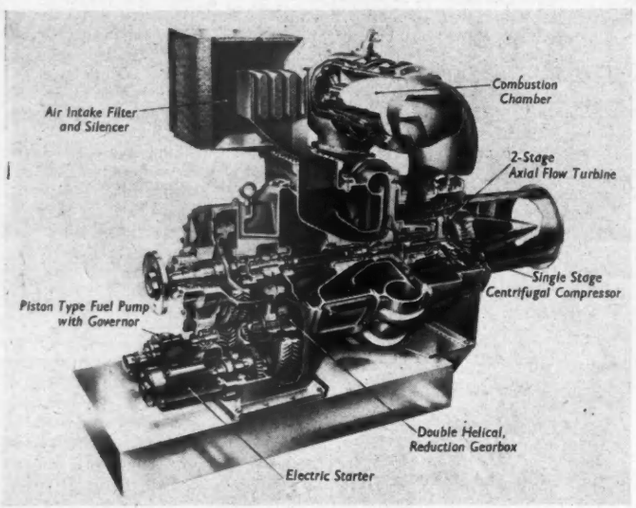
(*Above*) *The control panel of the automatic provender mill, and* (*below*) *a part of the mill itself.*

Stepping Stone to a Vehicle Gas-Turbine

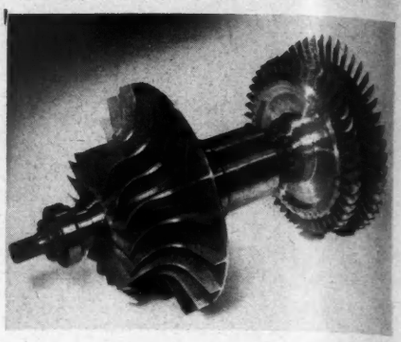
Austin's new 250 bhp industrial gas-turbine is the result of twelve years concentrated effort by the BMC. It forms an interesting stage in the quest for an efficient vehicle gas-turbine.

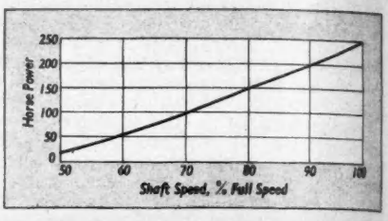
A GAS-TURBINE unit specifically designed for industrial purposes has been introduced by the Austin Motor Company Limited, Longbridge, Birmingham. At the same time, the turbine provides a major step forward towards the final production of a road vehicle turbine.

In 1955, Austin fitted a 120 bhp gas-turbine into one of their Sheerline saloons and it was used as a mobile test bed to assess the problems of the vehicle gas-turbine. It was found that 120 bhp was too small a unit to perform satisfactorily and in the improvements which have culminated in the industrial version now being offered, the rating is given as 250 bhp.

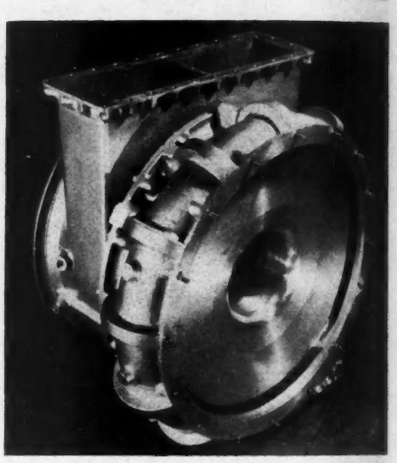


(Left) Cutaway view of Austin 250 bhp industrial gas-turbine showing the simplicity of layout.





(Right top) The single stage compressor and the two stage turbine designed for 29,000 rpm. The compressor casing (third down) is cast in aluminium to very fine limits. The graph shows minimum to maximum power developed within the speed range of the unit, based on 60° F ambient temperature at sea level.



The turbine—which has been developed at the British Motor Corporation's Turbine Department at Longbridge—is a single shaft machine in which the turbine rotor drives the centrifugal compressor at a speed of 29,000 rpm, giving a pressure ratio of 3·5 to 1. The power is taken out from the rotor assembly through a two-step layshaft reduction gear. The output speed is reduced to 1,500 rpm for 50 c/s electrical generation, but the unit could be supplied for any required speed.

Weighing only 900 lb, the turbine in its basic form measures 37 in long, 35 in wide and 51 in high. These factors together with its simplicity make the turbine suitable for applications where space or lightness are at a premium. With the relatively high cycle temperatures of 800° C used in the unit, a high overall thermal utilisation may be achieved in applications where use can be made of the exhaust heat for process work. Designed to run on gas oil or DERV, the unit is also suitable for conversion to other distillate or gaseous types of fuel.

Initially the unit will be available in three forms all without heat exchangers:—

(1) Coupled to a 160 kW alternator for electrical power generation; (2) coupled to a centrifugal water pump; (3) as a separate power unit for driving almost any kind of industrial plant.

Automatic devices are fitted to the unit to protect it from overspeed, excessive temperature and loss of lubricating pressure.

The impeller and separate guide vanes of the single-stage centrifugal compressor are machined from RR 58, a high tensile aluminium alloy, and are shrunk on to the shaft. A diffuser of aerofoil vanes is used, and the compressor casing is cast from aluminium alloy to give maximum strength to weight characteristics.

Of the axial flow type, the turbine has two stages. The rotor blades and discs are machined from Nimonic 90 forgings. The blades themselves are individually attached by a fir tree root which Austins have developed by photoelastic methods and successfully tested under simulated running conditions for as long as 2,000 hours. The first and second stage nozzles being precision castings do not require machining on the blades' aerofoil form. The rotor is carried on two bearings, one ball and one roller and are oil jet lubricated.

Joseph Lucas Limited have supplied the fuel system and the combustion chamber for the turbine. A single combustion chamber is used with side entry, having a Nimonic 75 flame tube in an aluminiumised mild steel outer casing. Fuel is supplied through a Simplex atomiser from a piston-type fuel pump incorporating a governor control. 98 per cent is the figure given by Lucas for the degree of combustion.

Starting is automatic, initiated by push-button. The unit is driven up to light-up speed by a 24 V dc motor mounted on the gearbox driving through a sprag-type clutch. Relays and solenoids give control to the admission of fuel, ignition, switching off the starter and the control of acceleration.

The normal output shaft speed of 1,500 rpm is geared down from the rotor speed of 29,000 rpm through two simple pairs of gears which are double helical, thus preventing end thrust on the bearings. Further spur gears driven from the layshaft provide auxiliary drives. Ball and roller bearings are used throughout the gearbox and the drive from the turbine rotor to the input gear is taken through a floating splined shaft. Separate oil feeds are taken to all high-speed bearings and also to oil jets on the main gears.

Lubricating oil is contained in a fabricated steel tank of 20 gals capacity, which also forms a bed on which the engine and gearbox are mounted. A double Hobourn-Eaton rotor pump serves two separate oil circuits from the oil tank, one to feed oil under pressure to all the bearings and gears through a full-flow filter, and the other to circulate oil through a cooler which will normally be cooled by water but may be cooled by air from a fan if water is unavailable.

Silencing is obtained by intake and exhaust silencers which together with sound absorbent covers render the turbine reasonably quiet. The complete generating or pumping sets are mounted on a fabricated frame into which the power unit fits and which is extended to carry the generator or pump. A light frame bridging the generator or pump carries a 50 gal fuel tank giving 1½ hours full-load running on one filling. As yet, Austin are not offering a heat exchanger, but as the technique of brazing—which at the moment is difficult and expensive—is improved, this may be possible. For any application where fuel economy is not important, the unit can compete with the diesel engine. With a heat exchanger the gas-turbine would do better, but as yet it is not possible to produce a unit at an economic price.

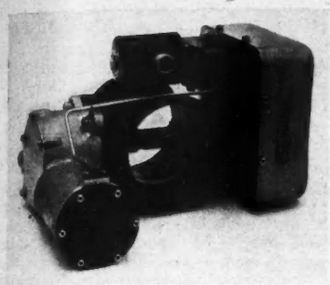
Applications of these units include a wide variety of uses such as emergency electric power sets, water or fuel pumping. The turbine is particularly suitable for fire fighting applications with its ability to deliver full power almost instantly after long periods out of use.

Although this unit has been designed for industrial purposes, it forms another stage in the development of a gas-turbine which can power a road vehicle. The Government have awarded a contract to Austin to develop a small gas-turbine and although this unit is still confidential, valuable information has been obtained from this work which has contributed considerably to the success of the 250 hp industrial gas-turbine.

Butterfly Valve for Engine Bleed Air

Increasing use is being made in jet aircraft of air bled from the engine for a variety of purposes. These include boundary layer control, de-icing, jet flap blowing, cabin air conditioning, rain dispersal, bay heating or cooling and power for air-turbines. For most of these functions high flow butterfly valves are required.

The Hymatic Engineering Company Limited of Redditch, Worcs., has developed valves which are suitable for most of these applications and in particular for boundary layer control and



Butterfly valve suitable for applications needing air bled from an aircraft engine.

de-icing. A valve, known as Hymatic PAS 217, combines these two functions in one.

In a typical case, during take-off and landing, full engine bleed pressure of up to 200 lb per sq. in may be required to provide the high air flow necessary for boundary layer control. Through a solenoid stop-valve, the PAS 217 is selected and servoed from upstream air, to open wide. Under such conditions the air flow may be upwards of 8 lb per sec at temperatures of 400° C, and some of the valve components may reach this temperature. The ambient temperature may rise to 200° C.

A smaller air flow is required for de-icing purposes. A second solenoid valve selects the controlling function, and the downstream pressure at the de-icing slots is sensed and stably controlled between 25 and 35 lb per sq. in over the full range of upstream pressures. This has the action of giving air economy, and the aircraft range penalty due to de-icing is reduced to a minimum.

For normal flight, the valve is biased closed. In this condition, the leakage is maintained at a rate of below 1 lb per min. This low rate has been achieved by angling the butterfly on its spindle and fitting it with a sealing ring.

The makers claim that the valve is very flexible in its installation. The control mechanism may, if space is restricted, be mounted remote from the actuator/ducting assembly. Design has been approached as an integrated control system and not as a modification to an existing simple on/off butterfly valve. This conception has resulted in a valve which weighs only 9 lb.

The company is currently developing a 4 in combined stop/reducing valve which will handle air flows up to 4½ lb per sec when controlling air temperatures of up to 550° C. The weight of this valve is expected to be little more than 10 lb.

Easier Reading of Ship's Telegraph

In order to satisfy the demand for a ship's telegraph with a clearer peripheral and side indication, a new quadrant type is being manufactured.

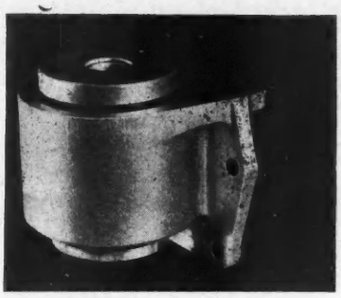
An assymetrical positioned quadrant head gives the operator a clear view of all the peripheral orders without stretching or leaning, and the choice of side dials with 15 in visible diameter results in a dial easily read from the extremes of the widest bridge. The makers, A. Robinson and Company Limited of Knowsley Road, Bootle, say that their proven electrical system of ac and dc telegraph is maintained for the new instrument. Maintenance is said to be nil as full use is made of plastic bearings in conjunction with stainless steel shafts.

Where a system demands two or more instruments on the bridge, the use of bevel gears and shafting in lieu of the more normal wire and chain connection ensures the correct indication of orders on all transmitters in the system. This particular type of quadrant head is well suited to desk mounting and can be supplied ready mounted with any other instruments required, on a desk or console.

Easily identifiable and removable fuses are sited on the side of the constant ringing relay box. The wide use of sealing rings and stainless steel screws externally reduces the possibility of corrosion and ensures complete proofing against weather conditions. The telegraph incorporates the bridge alarm buzzer in the transmitter and improved illumination is given to the transmitter dials. Tropical insulation is fitted throughout on all units and cables, thus safeguarding against extreme ambient temperatures.

Simple Fitting for Flexible Mounting

The flexible mounting shown in the illustration was originally designed for resiliently mounting large capacity tanks to the chassis of road vehicles. Silentbloc Limited of Manor Royal,



Flexible mounting takes load of 5,000 lb.

Crawley, Sussex, say that the simple four bolt fitting makes it a practical proposition for other applications.

The mounting can take a maximum load of 5,000 lb and the vertical deflection is given as approximtely $\frac{3}{16}$ in.

Encapsulated Transformer on Trial

In an article on p. 293 in our 24 February issue, we drew attention to the new range of electric motors which Newman Industries of Yate, Bristol, are producing with encapsulated windings. Now from America comes news of what is said to be the first practical encapsulated distribution transformer.

International General Electric—a division of the US General Electric Company—say that the new transformer eliminates paper insulation and about 99 per cent of the oil from the core and coil. It is said to have a dielectric strength equal to that of conventional transformers, as well as being 25 per cent lighter and smaller. The new unit, which will be rated at 80° C average winding temperature rise, incorporates a new epoxy resin developed at the GE transformer insulation laboratory.

Although GE have no plans to market the transformer, they believe that further development will eventually lead to encapsulated transformers that can be made at a competitive cost. Trial installations of approximately 100 packaged units are scheduled for this year.

Encapsulated transformers will be included in a unit for residential use which will include load-break disconnect switches and meters which will give consumers complete control in restoring power. Such units will be connected *via* a service entrance panel containing a low-voltage circuit breaker whose trip characteristics are coordinated with the load capabilities of the transformer to provide full overload protection for the transformer. This will give better voltage regulation by eliminating the need for secondary runs.

High-Speed Derricking Unit

An independent high-speed derrick unit and a swing brake are now available for Smith " 12 " excavators and crawler cranes made by Thomas Smith and Sons (Rodley) Limited, of Rodley, nr. Leeds.

These two units will enable the crawler-mounted machine to hoist, slew and derrick simultaneously and, if used in conjunction with the special planetary-load-lowering drum unit which is also available, they will transform the " 12 " into a sensitive precision crane. On new machines, this equipment is offered as an optional extra.

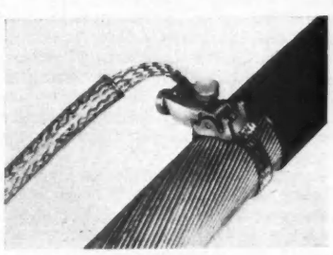
The derrick unit comprises a totally enclosed worm-driven drum-unit which is powered from the first machinery shaft by spur gearing through a pair of friction clutches, all of which are encased and use the basic machinery oil for lubrication. An automatic brake is fitted with an interlock device to prevent the clutches being applied should the brake become out of adjustment. Independent derricking is controlled by a " dead-man's handle," which on being released returns the whole system to safety.

A hand operated swing brake is fitted to the first machinery-shaft clutch disc, which controls the drive to the slewing motion. This brake, which is said to be very light in operation, is of twin-shoe construction, and is operated by over-centre control.

Temporary Continuity Connector

A simple and efficient device is now available for temporary connection of armour wires or tapes, metallic sheathing, or concentric neutral wires of electric cables while jointing on a live network.

The Hepworth Iron Company Limited, 116 Canbury Park Road, Kingston-on-Thames, Surrey, are the manufacturers, and they claim that it is suitable for temporarily bridging gaps in pipes, structural metalwork, and machinery:



This device allows for electrical continuity during a period of mechanical separation.

in other words, where it is necessary to maintain electrical continuity during a period of mechanical separation.

The connector comprises two nickel plated bodies joined by heavy tinned copper braid and housed in thick transparent plastic sleeving. After passing the free end around the cable, the braid is hooked into a hinged claw fitting, pulled tight and secured by the screw shown at the far side of the body. Intimate contact is then established by tightening the other screw.

On the Shelf

By Frank H. Smith

IT IS not often one of the engineering institutions gives a platform to the information side. It is therefore gratifying to see that the Institution of Locomotive Engineers heard a paper (21 February) on "The collection and assessment of technical information, including the language problem," by Joan Ritchie and B. R. Byrne, of the British Railways Research Department. A 25-item bibliography gives an idea of the research that must have gone to this paper and, unlike most librarians' papers, it was not a case of preaching to the converted or the inconvertible. The language problem here means things like Russian and not what goes on in the marshalling yard when a wagon runs over a ganger's foot.

I don't want to get involved in anything that is involved but Publishing and Distributing Company Limited (Mitre House, 177 Regent Street, London, W1) send us a "release" from International Scientific and Technical Service (PO Box 1235, Pomona, California) saying that they announce the formation of a new division to handle licensing arrangements and related problems between US firms and companies overseas. This offers a method of exporting technical know-how instead of goods.

Gille Associates Inc., of 22nd Floor, Book Tower, Detroit 26, Mich., USA, have got hold of my address and tell me that my applications of data processing systems are unique. They can say that again. They try to persuade me to buy some pretty expensive handbooks, an encyclopaedia, an annual and a monthly. If *your* systems are unique as well you had better drop them a line and let the postman trudge up to that 22nd floor.

In No. 3 of the European Productivity Agency (3 rue André Pascal, Paris) *Russian Technical Literature*, is a report of the unanimous recommendation of delegates (one assumes to E.P.A.) to create a European Translations Centre in Delft for Russian scientific and technical literature. I wonder if the dictionary people have considered as a definition "Translation—the rendering of Russian into English"?

In the American Society of Mechanical Engineers' annual report for 1960 there is a quite interesting little table from which figure-hunters may like to provide themselves with food for statistical tables. The Society with its various committees provided, in 1959-60, 333 meetings sessions at which 807 papers were given. 670 of these were available in printed form. The total attendance at the meetings was 22,287.

Some of the latest developments in electronic engineering are illustrated in the "Annual Review of British Electronic Engineering" (Electronic Engineering Association, 11 Green Street, London, W1). The review naturally has a slight bias in favour of British electronics but it is most heartening to read of an industry that is up-and-up.

Celebrating 50 years, B. G. Teubner Verlagsgesellschaft of Stuttgart have brought out a nice fat catalogue of books published by them. Most of the titles might have interest for the readers of this column providing they have leanings to Mathematik, Physik, Maschinenbau, Elektrotechnik, Hoch- und Tiefbau usw.

"Laboratory and Workshop Notes" 1956-58 is the fifth selection reprinted from the *Journal of Scientific Instruments* compiled and edited by Ruth Lang. Arnold are the publishers (for the Institute of Physics) and it costs 40*s*.

If this column shows signs of occasional tetchiness it is because I now have a secondhand typewriter that shies at some letters (can you blame it?) and I tend to get impatient at having to backspace and rebang. They tell me I can get income tax allowance and as I got the thing chiefly so that I could type my letters to the Commissioners I consider this poetic justice of a high order.

Expertise in Managerial Perspective

Engineering Management. By STRUAN A. ROBERTSON. 2nd Edition. *Blackie.* (30*s*)

Teaching management to students is exceedingly difficult. How far it is an art and how far a science can for the moment be left to the theoreticians. It is certainly much concerned with experience, with handling people, with sifting evidence and finding a compromise very often among conflicting points of view. Its expertise is therefore acquired at least in part from a practical background. Even those who must teach it with a limited first hand knowledge of industry at least come to the subject with a mature intellect.

The student is ill equipped in these matters. Those who write books about it must therefore make them readable and readily intelligible, for the student must be led by proxy into a world of mature experience of which he has but little conception. Most students are busy acquiring some kind of technical background, and can hardley be expected to grasp fully how their own technical discipline can be fitted into an alien and shifting strategy of management.

This book, now in its second edition (the first came out in 1948 and has now been revised to take into account changed industrial conditions) has much to recommend it.

Having dealt with the social, political and economic background to management problems the author considers the subject as a science and relates it to the development of scientific methods in established disciplines, including engineering. It then goes on to the practice of management, following a commendably logical pattern beginning with market research, design and production planning. It then takes the student quickly over a wide range of factory management problems including inspection and control. It concludes with a section on controls, including financial controls. It has in consequence the merit of being a rounded work although written primarily for student engineers.

Inevitably in a book of this sort, there must be a sacrifice of depth to breadth. Subjects on which whole textbooks have been written can be granted only a few pages but there is a useful bibliography to most sections for those who wish to read further. There is also an index.

A book of this kind deserves to be looked at as a whole by the young specialist. It is discursive in style but is none the worse for that for one can always use the index. There is a need for young engineers to see the commercial objectives in engineering work for the majority cannot expect, and probably do not wish, to stay in academic life or go into professional practice. If engineers of the next few generations are to take the highest administrative positions in business they must get a sense of balance early and realise that they will specialise in their early careers only to broaden out later. This book helps to get the perspective right.

G. E. TEWSON

Instrumentation for Radiation Physics

Nuclear Electronics: Proceedings of the International Symposium on Nuclear Electronics, organised by the French Society of Radio-electricians, Paris, 1958. 2 volumes. *International Atomic Energy Agency, Vienna: HM Stationery Office, London.* (24*s*)

Shortly after the second Atoms for Peace Conference in 1958 the Société Française des Radio-electriciens held an international "colloque" in Paris on the subject of nuclear electronics. The timing of this conference in relation to the Geneva conference was well chosen to ensure the participation of experts already gathered together in Geneva. There the leading roles were filled by the atomic scientists; the specialists in electronics came to learn, as all good engineers should, just how and why their products were being used and what new problems they would be required to solve in the future. How logical, then, for these self same specialists to foregather afterwards in Paris and present papers on the design of the electronic equipment which plays such an important part in furthering the advancement of nuclear science.

The International Atomic Energy Agency, charged with the task of "accelerating and enlarging the contribution of atomic energy to peace, health and prosperity throughout the world" rightly considered the publication of the conference papers in collected form as meriting its support. The outcome has been the printing of the 87 papers presented at the "colloque" in two volumes containing altogether nearly a thousand pages.

The papers are representative of work in nine different countries so that the publishers had a major task in scientific translation, and this impediment probably accounts for the long delay between the conference itself and the appearance of the volumes. It is as well, therefore, that the translation of the contribution from France, which amounts to half the total, was not attempted! English engineers with their traditional reluctance to make use of foreign languages should not, however, be daunted. A moderate knowledge of French will suffice to translate the essentials of the papers and the task is not without its lighter side. Even the narrowest of technicians would pause in his reading to savour such delightful phrases as "des contamination brutales," so vividly descriptive and leaving so little to the imagination.

The publishers have adhered strictly to the classification of papers adopted at the conference, using the same nine headings: (1) scintillation detectors; (2) radiation detectors using ionising methods and gamma ray spectrometers; (3) pulse techniques, fast electronics; (4) pulse techniques, classical electronics; (5) reactor control, measurements; (6) reactor control, simulation; (7) equipment for prospection and protection; (8) centralisation and exploitation of results (data reduction); and finally (9) transistorised equipment, standardisation and components.

The net has, therefore, been cast very wide as far as subject matter is concerned, but a study of the countries of origin of the papers shows, as is so often the case, a preponderance of material from the United States, United Kingdom, France and Italy. In fact, 90 per cent of the contributions came from these countries: regrettably there were none from the Soviet Union.

The French participation, amounting to half the total, was particularly dominant in the fields of reactor control and centralisation of results (data reduction), and this, no doubt, reflects the emergence of France as a major participant in the nuclear field. However, French engineers and scientists would be the first to agree that there are often as many good solutions to a problem as there are research centres and readers of these volumes would do well to bear this in mind.

No one browsing through the papers of this convention could fail to be struck by the extent to which the authors strayed into the realms of the nuclear physicists and the reactor designers. It is indeed characteristic of electronic aids for nuclear science, more perhaps than for any other application, that the designers are required to have an adequate general knowledge of the main subject itself. This requirement was, incidentally but none the less admirably, made apparent in two excellent survey papers, one by Dr. G. A. Morton of the RCA Laboratories on scintillation counters, and the other by Clyde Weigand of the

Radiation Laboratory, Berkeley, on fast electronics in high-energy physics.

It is interesting to see from these papers how the use of giant accelerators is demanding more exacting performances from particle detectors and fast electronics. This demand in turn leads to research on the behaviour of scintillators and photomultiplier tubes and a study of the problems of stability, noise and resolution. Development of the detectors must, of course, be paralleled by design of suitable electronic circuits, and already one can see resolving time requirements falling from the nanoseconds to the micro-microseconds region.

It is clearly impossible to review each and every one of the 87 papers presented; the reviewer must, of necessity, confine himself to some general remarks indicative of their content and scope. First let it be said that there is a wealth of material in these two volumes which will repay study and some of it will be of real benefit to those engaged in pushing back the frontiers of knowledge. It must also be said that, as with many gatherings of this type, the papers presented range widely in their appeal and in the contribution which they make to the advancement of their chosen subject. There are the inevitable papers which add little more than a change of emphasis or styling to what has previously been published. More valuable are the survey papers, of which there are several excellent ones, serving to provide the general reader with the signposts and milestones which are his interest. Finally, there are the many specialist papers, which record progress and the results of measurements, advance theories, and which, therefore, provide a valuable basis for discussion and further experiment.

The reader of a collection of papers intended to record progress in a defined sphere of science or engineering will always, after his task is complete, be left with several strong impressions.

This reviewer has been struck by the paucity of development of special electronic circuit devices, adapted to the needs of nucleonics, compared with the wealth of development of special nuclear detectors. For example, one looks in vain in the papers on fast pulse circuits for new circuit devices which really represent an advance in technique. Yet in the same session, Dr. Marron described a photomultiplier having a time resolution an order of magnitude better than conventional high-speed tubes.

Can one perhaps hope that the publication of this useful record of progress will help to stimulate the development of devices designed specifically for the needs of nuclear electronics?

R. B. STEPHENS

Sources of Error in Temperature Measurement

Radiation Pyrometry and its Underlying Principles of Radiant Heat Transfer. By THOMAS R. HARRISON. *Wiley, New York and London.* (96*s*)

Temperature measurement is rarely easy and the use of a temperature measuring instrument outside the often narrow range of conditions for which it was designed may lead to large errors This is especially true when using radiation pyrometers where it is necessary to appreciate fully both those errors arising from the characteristics of the pyrometer, such as the effect of ambient temperature and the design of lenses and mirror, and those due to the often complicated relationship between the temperature of the body under examination and the contribution of its radiant energy to that received at the instrument.

Anyone who uses radiation pyrometers in any way except the most standardised is strongly advised to read the book under review and not to be put off by the somewhat mathematical appearance of the text. It is likely that many people may have their faith in the readings they have been making shattered, but the book is constructive in nature and should enable them to make full and accurate use of their instruments and obtain readings in which they can have reasonable confidence.

The design and calibration of radiation pyrometers both for high and low temperature applications is described (the term " radiation thermometer " for low temperature instruments is wisely discarded). The optical system is of necessity dealt with in some detail, and a section on the use of " light guide " transmitters, in which the radiant energy is transmitted from source to receiver along a length of rod composed of a suitable substance transparent to radiant energy such as a synthetic sapphire, is somewhat novel and particularly interesting. The book has an ample selection of tables and charts which, while in some cases tied to the instruments which the author has been most closely associated with (particularly the Brown " Radiamatic "), will be of general use in evaluating reliable correction factors for lens absorption, emissivities of the emitting surfaces and so on.

The book has an additional virtue worth stressing in that the early chapters give a very clear account of the ramifications of the laws of emission, absorption, reflection and transmission of thermal radiation. In particular, the arguments are carefully built up step by step and form a most useful means of clarifying the mind on these topics.

G. G. THURLOW

Commercial Oligopoly in Britain and America

The Antitrust Laws of the United States of America. By A. D. NEALE. *Cambridge University Press.* (45*s*)

The Control of Monopoly in the United Kingdom. By PAUL H. GUENAULT and J. M. JACKSON. *Longmans.* (25*s*)

Monopolies arouse stronger emotions to the published square inch than almost any other topic. One of the services rendered by Mr. Neale's comprehensive, readable study is that he disentangles the emotional and logical objections to monopoly. Different people maintain variously that (1) excessive concentration of private economic power is evil; (2) the small man should be preferred to big business; (3) competition should be promoted; (4) price agreements, collective boycotts, division of markets, etc., are bad.

None of these objections is always easy to reconcile with economic growth. By making better and cheaper mouse traps, a firm may, without unfair practices, put all competitors out of business, and the price of mousetraps may be less than if there were competition. Has it therefore an " excessive" concentration of power? Must its monopoly be dissolved and the public forced to pay more for the sake of a principle?

That competition is good is a reasonable generalisation, but over broad stretches of an industrial economy, mass production methods, and the large capital required to build plant and to carry out research, inevitably tend to oligopoly, in which a few big firms compete in the production of, say, motor cars or chemicals.

Then, again, what about resale price restrictions? The small shopkeeper, with his several assistants and comparatively heavy overheads, regards these restrictions as his defence against being swallowed up by supermarkets, which by making the customer himself choose and carry, and by channelling him out via a four-laned exit to a mechanised process of payment, cuts labour costs, while bulk buying enables prices to be slashed. Is, then, all for the best? Not so, for it emerges from Guenault and Jackson's study of monopoly in Britain that if the price agreements condemned by the court had not enabled large, easy profits to be made, they did nevertheless promote rigidities in production and distribution, and weaken incentives to improve methods and reduce costs.

How is a court to decide when oligopoly is good or bad, when the small man should be upheld or allowed to be absorbed? These two books reveal the different British and American answers.

British and American law both prohibit agreements to restrict prices and conditions of trading, processes of manufacture, areas, and persons with whom business is done. There the resemblance ends. In the United States, antitrust's aim is to uphold competition and to disperse excessive concentrations of power. Nevertheless, neither the mere size of a firm, nor the existence of an oligopoly as such is illegal. This flexibility is a practical recognition of economic realities.

What *is* illegal is the creation of a monopoly with *intent* to monopolise, by buying up a weaker competitor or by agreement to share markets, or to discriminate against or exclude certain competitors, or by withholding the use of patents on payment of royalties. Monopoly is no offence: monopolisation is, and leads to enormous fines and possible imprisonment.

It is no defence that powers secured by oligopolisation have not been abused, that mergers have led to greater efficiency, that oligopolisation has sought only to end " excessive " competition, which would have led to business closures, and created unemployment.

The United States courts hold that (1) all these considerations are not matters of fact but questions of economic assessment or forecasting; (2) were the courts to allow economic experts to argue for and against the balance of economic advantage, the door would be opened to confusion. The circumstances of each firm and industry differ. Consequently, each case would be an *ad hoc* assessment, creating no precedent to guide other firms anxious to observe the law. Moreover, judgments would be limited in duration. Would today's " reasonable " price be " reasonable " tomorrow, or in five years? In short, what the US court has to decide is the *intent* of the defendants. Did they achieve oligopoly legitimately by making better mousetraps, or did they set out deliberately to oligopolise?

In Britain, it is open to an oligopoly to show that an agreement protects the public against injury arising from the installation, use, or consumption of goods; makes available other " specific and substantial " benefits to the public; counteracts restrictive measures taken by " any one person " not a party to the agreement; permits the negotiation of " fair terms " for the purchase or sale of goods with those who constitute a preponderant part of the trade; prevents " serious and persistent " unemployment in an area heavily dependent on the trade; maintains export earnings where they are substantial in relation (*a*) to Britain's exports as a whole or (*b*) to the whole business of the particular trade; or maintains some other restriction

which the court holds to be justified on its own merits.

Faced with defence arguments on any one of these points, the British court enters what is called the " balancing phase " of the hearing in which respondents have to prove that the restriction is not unreasonable having regard to the balance between the benefits resulting, or likely (*sic*) to result, and any detriment to the public or to persons not a party to the agreement. Guenault and Jackson point out that the court does not have to be satisfied that the benefits and detriments are evenly balanced, but merely that on the net balance, which may be adverse, the restrictions are not unreasonable. Thus, the court must balance (*a*) the specific justification for the restriction against (*b*) the actual or possible (*sic*) injury to the public and then decide whether the restriction is not unreasonable.

The Act gave economists for the first time an important role in British court procedure. Apt comment came from Professor A. Beacham who said that the issues were not usually of a kind to which an economist can give clear-cut answers on an objective basis, and if economists habitually expressed definite opinions on questions to which economics has no answer in any practical context, the standing of the profession would suffer. The economist would be more useful in marshalling and occasionally interpreting the facts.

The British Act also sets up a Monopolies Commission to consider agreements solely concerned with export trade and what are called " single firm monopolies," defined as any firm responsible for one third of the supply. But surely a monopoly is not a question of a percentage (which may vary over the years) but of fact? In the USA the courts found that although du Pont supply 75 per cent of cellophane output, the market is sensitive to price-changes and to substitutes and that du Pont in fact have no significant power in the packaging market taken as a whole.

In short, it seems arguable that as the given facts of any economic situation are, or at any rate should, always be evolving, the British Monopolies Act could, with the minimum of amendment by a government hostile to business men, be developed into machinery for the continuous supervision of a firm or an industry in order to allow for new circumstances, and so bring all the inflexibilities of government control in by the back door.

Most British commentators seem to think that antitrust in the United States has " failed." Of course, it has not achieved perfection. This is an imperfect world. It is only those who hold some vast, world-transforming faith, such as the final triumph of reason or of the proletariat, who believe that there exists a set of doctrines, which are absolutely correct, by means of which all political and economic problems can be solved, in the same way that a proper application of the laws of astronomy permit an eclipse to be predicted.

But Mr. Neale shows that the USA has achieved a workable compromise. Its law is based on faith in private enterprise and in competition, but seeks to make excessive concentration of private economic power difficult. Mr. Neale's evidence suggests that, as far as is humanly possible, they have succeeded. British antitrust law has not evolved enough to have crystallised. There is still time to reconsider it in the light of American experience.

JOSSLEYN HENNESSY

New Books

University College Ibadan. By J. T. SAUNDERS. *Cambridge University Press.* (22*s* 6*d*)

Written by the second Principal of the College, this historical account runs from the formal opening on 2 February, 1948, to the present hopes that the College may before long take its place as a university of the Commonwealth, granting its own degrees.

F. W. Lanchester: A Life of an Engineer. By P. W. KINGSFORD. *Edward Arnold.* (30*s*)

The life of a pioneer of aeronautical science and automobile engineering, which comprehended the span of progress from horse-drawn transport to the jet airliner.

Railway Locomotives. By JOHN R. DAY and B. K. COOPER. *Frederick Muller.* (9*s* 6*d*)

Another volume in the *Mechanical Age Library*, written for young people. The emphasis is on diesel and electric locomotives, although two chapters are given over to steam.

Domestic Heating. Edited by W. F. B. SHAW. *Temple Press.* (21*s*)

A group of contributors have been brought together to provide a guide to the selection of systems, fuels and appliances, which can readily be used by the intelligent lay reader.

Notes on Operations Research. Assembled by the Operations Research Center, M.I.T. *Crosby Lockwood.* (30*s*)

For the past six years the Operations Research Center at the Massachusetts Institute of Technology has given special summer programmes of lectures on topics in operations research for persons from industry, the services, and government departments. The present volume is one of a series of selections of material on recent developments in the field, produced for use in these programmes.

Edison: A Biography. By MATTHEW JOSEPHSON. *Eyre and Spottiswoode.* (42*s*)

A new biography of Edison which sets out to give him his due historical position as transitional between the lone inventor and organised research. It was Edison after all who established the world's first industrial research laboratory.

David Brown's: The Story of a Family Business, 1860-1960. By DESMOND DONNELLY. *Collins.* (21*s*)

A short history celebrating the centenary of this major engineering company. David Brown the First set up his company at the age of 17, to produce gear wheel patterns for a foundry. By 1873 the company was offering gears of its own manufacture—foreshadowing their present eminence in this field.

Continuous Casting of Steel. By M. C. BOICHENKO. *Butterworths.* (50*s*)

The metallurgist and the advanced student will find here a short survey of the present day position of semi-continuous and continuous casting of non-ferrous and ferrous metals, both in the Soviet Union and abroad.

British Locomotives. *Locomotive and Allied Manufacturers' Association, Locomotive House, Buckingham Gate, London, SW1.* (15*s*)

Profusely illustrated, this book shows the development, achievements and products of the British locomotive industry.

Institution of Mechanical Engineers: Proceedings of the Automobile Division, 1958-59. *Institution of Mechanical Engineers.* (41*s*)

The latest bound volume of the " Automobiles" includes papers on the fatigue testing of vehicle components, standards and standardisation in the motor industry, and the performance of vehicles in antarctic conditions.

The Autodyne: A New Electrical Machine. By OTTO BENEDIKT. 2nd Edition. *Pergamon Press.* (45*s*)

This novel machine, devised by Professor Benedikt, provides a means of controlling any quantity that can be made to depend on a direct current, using the ordinary fixed frequency ac power supply as the source of energy.

Thermoelectric Materials and Devices. Edited by IRVING B. CADOFF and EDWARD MILLER. *Reinhold Publishing Corporation, New York; Chapman and Hall, London.* (78*s*.)

Although the discovery of thermoelectric effects dates back to the early part of last century, it is the development of semiconductor technology during the past two decades which has made new materials of reasonable efficiencies available for refrigeration and power conversion. The present survey of recent progress is based on short courses presented at New York University.

Who's Who in the Gas Industry, 1961. *Gas Publications Limited, 175 Hagden Lane, Watford, Hertfordshire.* (7*s* 6*d*)

Up-to-date information on the personnel of the Gas Council and the Area Boards, together with a buyers' guide to sources of supply for gas industry equipment.

Directory of Opportunities for School Leavers, 1961. *Cornmarket Press.* (8*s* 6*d*)

The total number of companies and other institutions giving their recruitment needs is now 218 in this edition, with notable increases in the fields of electronics, mechanical engineering, chemicals, and civil engineering.

An Introduction to Electrotechnology. By S. J. KOWALSKI. *Chapman and Hall.* (35*s*)

Based on lecture courses given at the Polish University College in London, this textbook covers approximately the requirements of Part 1 of the London B.Sc.(Eng.) in Applied Electricity. MKS units are used, and problems (and answers) are included at the ends of chapters.

The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies. By EDWARD JOHN ROUTH. 8th Edition. *Dover Publications, New York; Constable, London.* (19*s*)

A facsimile reprint of the author's last revised edition, published in 1905.

The Reviewers

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Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant

Waste Treatment Plant. LINK-BELT COMPANY, Prudential Plaza, Chicago 1, Ill. USA. Equipment for the treatment of water sewage, and industrial waste is described in book No. 2617. 20 pp. ill.

Hydrogen Sulphide Scrubber. W. C. HOLMES & Co. LTD., PO Box B7, Turnbridge, Huddersfield. The Stretford process for the removal of hydrogen sulphide from gases, described in publication 84. 4 pp. ill.

Wood Refuse Collectors. STURTEVANT ENGINEERING Co. LTD., Southern House, Cannon Street, London, EC4. Cyclone and filter collectors for wood refuse, and complete installations. Folder 6604. 6 pp. ill.

Sludge Collectors. LINK-BELT Co., Prudential Plaza, Chicago 1, Ill, USA. Straightline sludge collectors for rectangular settling tanks, large or small, with or without skimmers; also auxiliary equipment. Book No. 2746. 28 pp. ill.

Heat Treatment Furnaces. ELECTRIC RESISTANCE FURNACE Co. LTD., Netherby, Queens Road, Weybridge, Surrey. Heat treatment furnaces for batch or continuous production with forced air circulation or under vacuum. Examples of types. 16 pp. ill.

Roller Hearth Furnaces. GENERAL ELECTRIC Co. LTD., Engineering Group, Erith, Kent. Roller hearth furnaces for air or controlled atmosphere heating. Standard sizes and special models up to 400 ft long. Folder. 4 pp. ill.

Shaker Hearth Furnaces. EFCO FURNACES LTD., Queens Road, Weybridge, Surrey. Standard range of shaker hearth furnaces with outputs up to 450 lb per hour at temperatures of 900° C. Brochure. 8 pp. ill.

Marketing

Export Incentives in Australia

THE Australian Government are to step up their overseas trade promotion and have decided to adopt further tax concessions in an effort to correct the balance of payments difficulties.

The tax concessions, applying for at least three years from 1 July this year, include twice the rate of remission for expenditure on overseas market development and a rebate of payroll tax related to the value of export sales. An interesting provision of this new incentive scheme is that firms providing materials and components to the exporting manufacturer will also be able to benefit.

Trade missions are to be sent to South America, on which some emphasis is being placed, and the Eastern Mediterranean. Early next year a display ship is to go to the Persian Gulf. Trade commissioner posts are to be set up in Venezuela, Peru, the Lebanon and Iran, once permission has been obtained from those countries.

The leader of the Opposition in the Australian Parliament, Mr. Caldwell, has declared that the export incentives will be useful only " in the sweet by and by." Australian manufacturers have welcomed the new moves although they see the results as taking a long time to materialise while the balance of payments problem is already in existence.

The Australian FORD Company have had to dismiss almost another 1,000 workers, bringing the total the company has discharged since November to 2,000.

Government Loan for Ulster Aircraft Firm

The heavy development costs of the Belfast air freighter, ten of which have been ordered by the Ministry of Aviation, have led to a Northern Ireland Government loan of £5 million to the aircraft's makers, SHORT BROTHERS AND HARLAND, of Belfast.

The company's plans are on the basis of manufacturing at least 30 of the big air freighters. Captain T. O'Neill, the Ulster Minister of Finance, said recently in the Northern Ireland House of Commons, when announcing the Government loan, that it was not thought the development costs would be recovered until the completion of the production programme.

Textile Machine Orders Signed at Leipzig

Intense interest and a great flow of highly detailed inquiries at the stands of the British exhibitors are reported from the Leipzig Fair.

Contracts are most likely to come later, through the centralised Soviet trading organisations, but already contracts for more than £1 million worth of textile machinery have been signed.

More than half this amount, £570,000, is covered by the proposed purchase of knitting machinery by TECHNOPROIMPORT from the BENTLEY ENGINEERING Company of Leicester. Textile machines worth £480,000 are to go to Czechoslovakia. The managing director of BRAMEAST TEXTILE MACHINERY, of London, explained that the negotiations for these contracts were carried on in Prague and Moscow at the end of 1960.

Delivery Time Kept within One Hour

A story of rapid delivery to West Germany comes from the DAVID BROWN MACHINE TOOL Division. A 65 ton gear cutting machine, built at Manchester, was delivered to the customer, in Duisburg, within four days of leaving the factory.

Using five trailer units, BRITISH ROAD SERVICES's Continental Ferry branch were able to do without much of the crating and careful packing previously required. Instead of the former 14 packing cases, the David Brown 1·25 metre horizontal heavy duty and precision pinion hobbing machine was dismantled no more than was needed to make the five loads for the door to door trailers.

At mid-week the five 15 ton trailers were towed from Manchester to Tilbury Docks where they were taken on the Bardic Ferry and so to Rotterdam. From the Dutch port continental tractor units took the trailers on to the customer—DEMAG AG.

David Brown's machine tool division give this list of the advantages in this method:

Time cut from the usual three weeks to only four days.
Packing virtually eliminated.
Handling risks much reduced.
Promised delivery time kept within less than an hour.
Delivery cost, in this case, cut by half.

There is, as always, one snag. Some of the single piece main castings used in the larger machines are too wide to allow being carried on road transport.

New Carrier for India from Harland & Wolff

The first aircraft carrier for the Indian Navy, the Vikrant, was formally commissioned earlier this month by Mrs. Vijaya Lakshmi Pandit, the High Commissioner for India. Originally ordered for the Royal Navy from VICKERS-ARMSTRONGS (SHIPBUILDERS) at their Newcastle-on-Tyne yard, the carrier was launched in 1945 and named HMS Hercules.

Construction was suspended in 1946 and she was sold to the Indian Government in 1957. The modernisation and completion contract went to HARLAND AND WOLFF, at Belfast.

The Vikrant has a displacement of 19,550 tons and a length of about 700 ft. Her flying complement will be Seahawks and Breguet Alize anti-submarine aircraft. The peacetime complement will be about 1,300 officers and men.

Main machinery has been built by the PARSONS MARINE TURBINE Company, made up of single reduction geared, turbines driving two shafts giving a total of 40,000 shp. Carrying out trials and working up in waters around the United Kingdom and in the Mediterranean, the Vikrant is expected in India in September.

Harland and Wolff have also completed a new motor driven cargo liner the Port Alfred, for the PORT LINE. She has been handed over following successful trials. Two other cargo liners are on order with the company for the Port Line, the first of them to be launched at Belfast later this year.

Shipping Consortium for Moscow Fair Freight

One of the most varied cargoes ever assembled at the London Docks for loading on one vessel is being carried to the Soviet Union on the Baltic Express. It is made up of exhibits, from a complete laundry to puppets and equipment for the British Fair to be held in the Moscow Sokolniki Park from May 19 to 4 June.

Some of the individual items swung into the holds of the Baltic Express weighed more than 30 tons, other loads were made up of parcels of not more than two or three pounds. Loading instructions in English and Russian are supplemented with visual signs indicating " fragile," " this side up " and other handling guides.

Shipping arrangements for 621exhibitors at the fair have necessarily been more than a little complex. INDUSTRIAL AND TRADE FAIRS Limited, organisers of the fair, have appointed a consortium of leading shipping and forwarding agents—BECK AND POLLITZER TRANSPORTATION, LEP TRANSPORT and LLOYDS PACKING WAREHOUSES GROUP.

A system of loading the Baltic Express was adopted so that the exhibits and equipment most urgently needed could be among the first unloaded at the Baltic port of Klaipeda. Much of the material for the fair has already been sent off by train. There will be some transportation by air.

Anglo-American Servo Valve Agreement

European and Commonwealth manufacturing rights of the full range of electro-hydraulic servo valves and associated electronic equipment designed by PEGASUS LABORATORIES Incorporated, of Detroit, USA, have been acquired by TELEHOIST Limited, of Cheltenham.

The Pegasus servo valves are high performance units designed for industrial, aircraft and missile applications. Their flow capacities range from 5 to 160 gallons per min at 3,000 lb per sq. in. Units for use by the aviation industry have flow ranges from 2 to 5 gallons per min at 3,000 lb per sq. in. Attention to the weight of the valves has brought the largest unit in the range down to only 15 oz.

Electronic equipment accompanying the servo valves is designed for dc and ac carrier systems.

Supergrid Switchgear from English Electric

Supergrid switching equipment worth about £700,000 has been ordered from ENGLISH ELECTRIC by the CENTRAL ELECTRICITY GENERATING BOARD for switching stations at Sundon, Bedfordshire, and Feckenham, Worcestershire.

The ten breakers, for the two 275 kV switching stations, are rated at 15,000 MVA 2,000 amps. They will be produced at the English Electric Stafford works. One of these units, the latest design in air blast circuit breakers, is being manufactured at Stafford for the Connah's Quay switching station, Flintshire.

These 275 kV, 15,000 MVA, 2,000 amp air blast circuit breakers, which are designated rT6C, are the first of a range of air blast breakers being made by the company to cover voltages from 132 kV up to 550 kV and above.

French Airframes and Rolls-Royce Engines

The Marcel Dassault Mirage III supersonic interceptor fighter, powered by the Avon turbo jet, has recently completed its first flight at the DASSAULT airfield in France, three weeks ahead of programme.

The Mirage is the third Dassault aircraft to be equipped with ROLLS-ROYCE engines. Its turbo jet is fitted with an afterburner giving greater all round performance for the " export version " of the outstanding French Mach 2 interceptor.

The Mirage III has been chosen for the re-equipment of the Royal Australian Air Force. It is also going to the Swiss Air Force. Rolls-Royce connection with French aviation developments is of long standing. Versions of the Nene and Tay (Verdun) engines were manufactured in France and used in the Ouragan and Mystere interceptors.

Under recent arrangements, Tyne engines are to be made in France for the Breguet Atlantic, the NATO maritime reconnaisance aircraft. Dart engines from Rolls-Royce are in use on the Breguet Alize antisubmarine aircraft which has been ordered for the naval air forces of France and India.

The celebrated SUD AVIATION " Caravelle," now in service on many world airlines, gets its power from Avon engines.

Gear Units for Drakelow and Bankside

For use in the CENTRAL ELECTRICITY GENERATING BOARD's Drakelow " C " and Bankside " B " power stations the HARLAND ENGINEERING Company, of Alloa, Clackmannan, Scotland, have ordered six Allen-Stoeckicht epicyclic gear units for motor driven boiler feed pumps from W. H. ALLEN SONS and Company of Bedford.

The gears are to be built at Allen's Atlas Works, at Pershore, Worcestershire. The four Drakelow units will be 5,650 hp speed increasing gear units, each designed to increase the motor speed of 1,460 rpm to the pump speed of 4,500 rpm. The two Bankside units will transmit 2,700 hp continuously and increase the motor speed of 1,490 rpm to the pump speed of 5,500 rpm.

AEC £600,000 Order from South Africa

Two hundred chassis of various designs have been ordered from AEC's South African company AEC VEHICLES (SA). Of the chassis, 84 are for the 14 ton Monarch, the lightest of AEC's goods vehicles.

The rest of the order includes 48 Mandator heavy duty vehicles, 16 Ranger and 4 Reliance passenger chassis, 28 Mammoth Major six-wheelers and 20 Mammoth Major eight-wheelers.

In the past 18 months AEC vehicles sales in South Africa have increased by 700 per cent. This latest consignment will be worth £600,000.

The APV Plate Evaporator

The dairy industry has so far reaped the biggest benefit from the APV plate evaporator. But it is no less successful for other process work in the food and chemical industries.

EVAPORATORS serve the process industries in in many ways and are used for many products. Perhaps the best known application is in the concentration of liquid foods which are sensitive to heat.

The main purpose of concentration is to reduce the bulk of the product in order to cheapen storage and transport. Also improved keeping quality often results. With certain liquid foods flavour, colour and nutritive value are easily affected by high temperatures or long periods of treatment. The APV plate evaporator is successful because it is kind to the product.

The degree of concentration desirable or possible depends largely on the physical properties, in particular the viscosity, of the final product. Orange juice, for example, is normally concentrated to 1/7 of its original volume; and milk to about 1/5, after which it is often dried to a powder. These concentrates or powders can be reconstituted by adding water.

Conventional recirculatory evaporators of the tubular type possess serious disadvantages in handling heat sensitive foods. The APV plate evaporator has succeeded in overcoming most of these difficulties, thus proving once again that a breakaway from convention can provide the answer to long-standing problems. It owes its basic conception to a predecessor which pioneered the application of the plate principle, the plate heat exchanger.

Originally known as the Aluminium Plant and Vessel Company Limited, the APV Company Limited, of Crawley, Sussex, was started in 1910 by Dr. Richard Seligman, who is still president of the company today. Since that time it has grown to an organisation employing over 2,000 in the main works, and has a large network of associates and agents overseas.

After the First World War Seligman started thinking about plate heat exchangers in connection with milk pasteurisation requirements, for which the conventional tubular type was not entirely suitable. Although the plate type had, in fact, been considered before, Seligman was the first to succeed in putting it on a practical commercial basis. The first unit, produced in 1923, used cast gunmetal tinned as the " plate " material. By 1934 the availability of stainless steel in sheet form made it possible to manufacture a heat exchanger with pressed stainless steel plates. The new material offered great advantages in resisting corrosion, and also provided a surface which could easily be cleaned either by hand or by chemical circulation; so vital when handling foodstuffs liable to spoilage by bacterial action.

After the Second World War APV made some conventional circulatory tubular evaporators, mainly for milk, but about that time a great emphasis came on the economies of evaporation. Accordingly, a mock-up plate type unit was made in 1951 to test the principle.

TECHNICAL MERITS

The success of the plate evaporator since that time has been due primarily to the technical merits arising from good performance coupled with saving in height and space, ease of control and steady operation.

Probably its most important feature is the extremely short " hold-up time " as it is called, to which the product is subjected during concentration. Although the actual time differs with size and duty, generally concentration is completed in each stage or " effect " in about half a minute, compared with perhaps an hour or more in a tubular evaporator.

A glance at the construction of the plate evaporator in Fig. 2 will reveal that its characteristics are entirely different. In the tubular type the product is circulated through a nest of tubes within a shell where it is boiled by the action of steam within the shell, which means that a comparatively large quantity of product is in circulation and being subjected to heat at any time. Cleaning is also difficult, and because of its height a tubular unit usually demands a special building, as Fig. 1 illustrates.

The plate evaporator consists of a series of plates suspended from a bar in a frame and held in contact with one another, the number of plates or units depending on the required duty. The experimental work started in 1951 was directed primarily towards making the machine operate on a single pass circuit, since if recirculation could be dispensed with then improvement in product quality could be expected. The experimental unit was circular with the plates arranged horizontally. The product, in this case sugar solution, was fed in at the centre and flowed radially outwards.

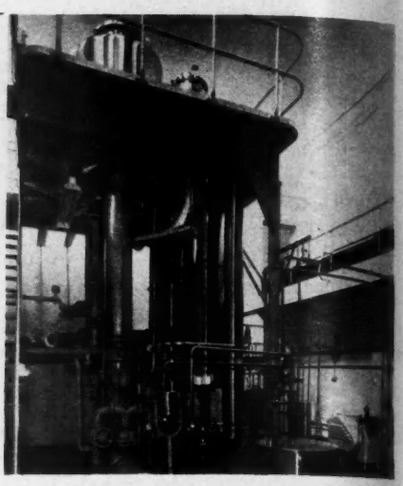

Fig. 1 Typical tubular evaporator.

The results were not entirely conclusive but were sufficiently encouraging to pursue further investigation. After a number of other shapes had been tried it became evident that a rectangular plate mounted vertically was the most practical arrangement, both from performance and manufacturing standpoints.

The chief difficulty encountered in plate design is to ensure satisfactory distribution of the liquid product. If any portions of the plate area remain unwetted by the product, local overheating and perhaps difficult cleaning will result. " Climbing film " operation, in which the product is fed in at the bottom and rises during evaporation, gives good distribution but has the disadvantage that product extraction is not easy, and a considerable temperature difference is necessary to maintain circulation. " Falling film " operation, on the other hand, gives good

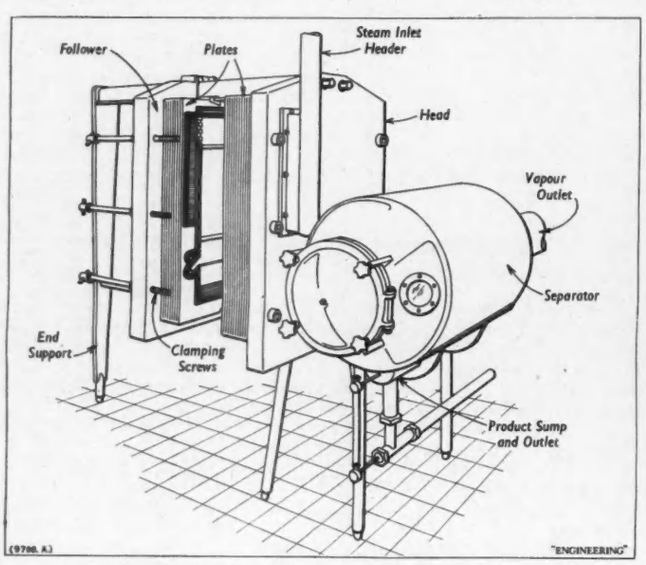

Fig. 2 Single effect evaparator and separator.

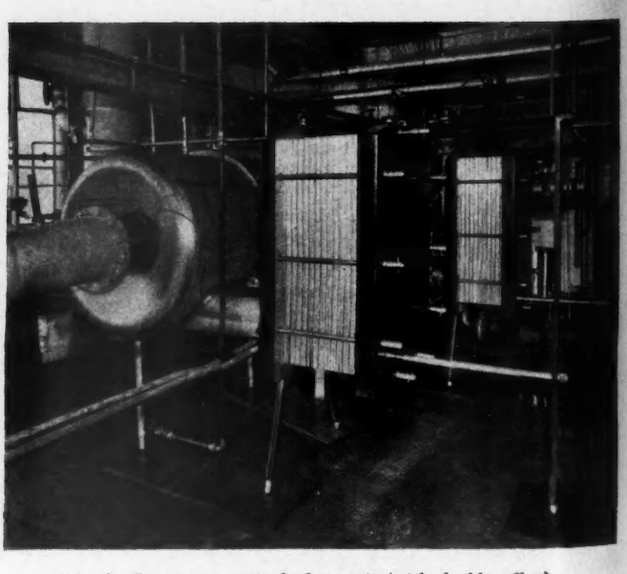

Fig. 3 Prototype vertical plate unit (with double effect).

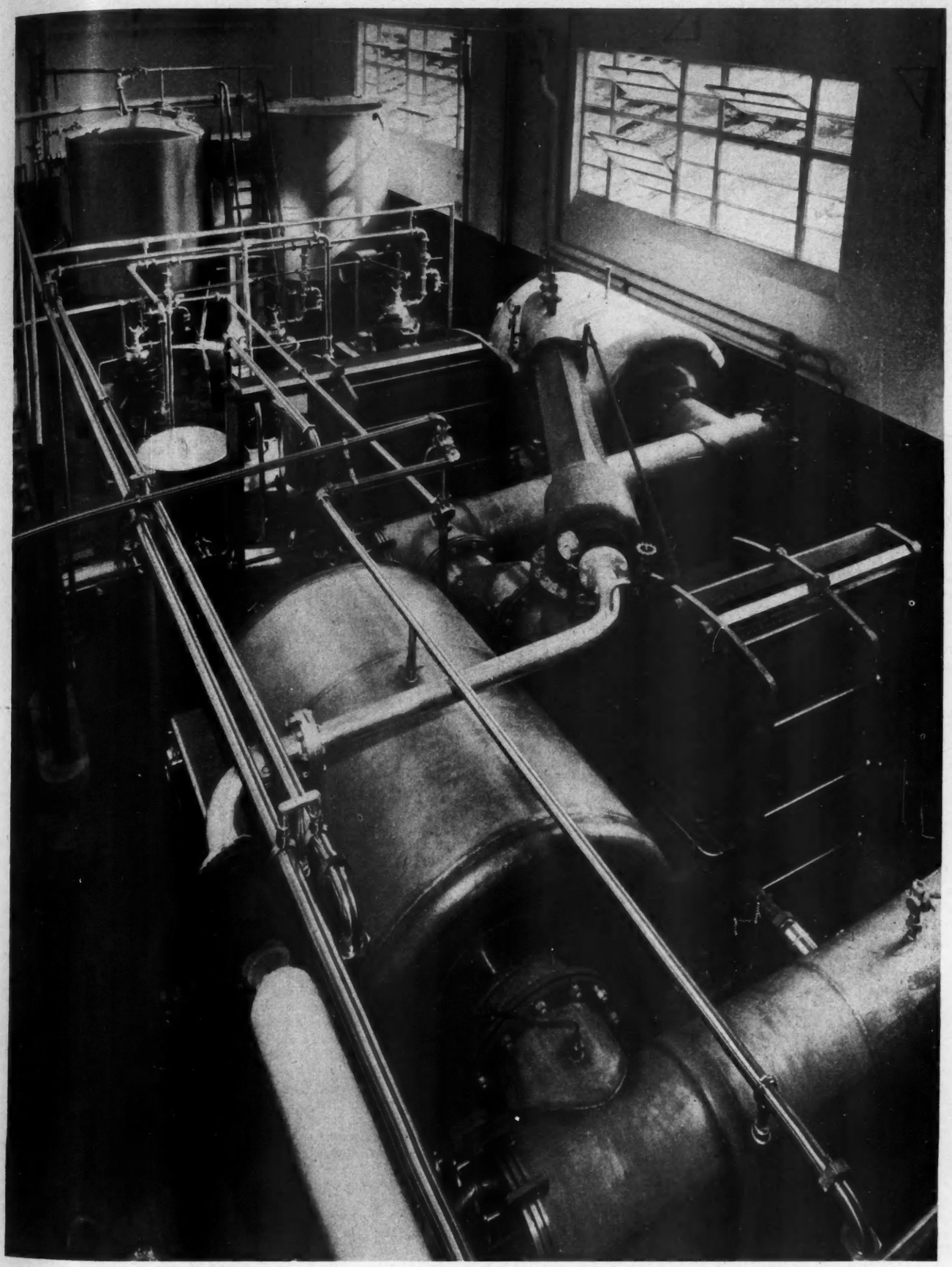

Fig 4. The central theme of a plate evaporator system—kindness to the processed product.

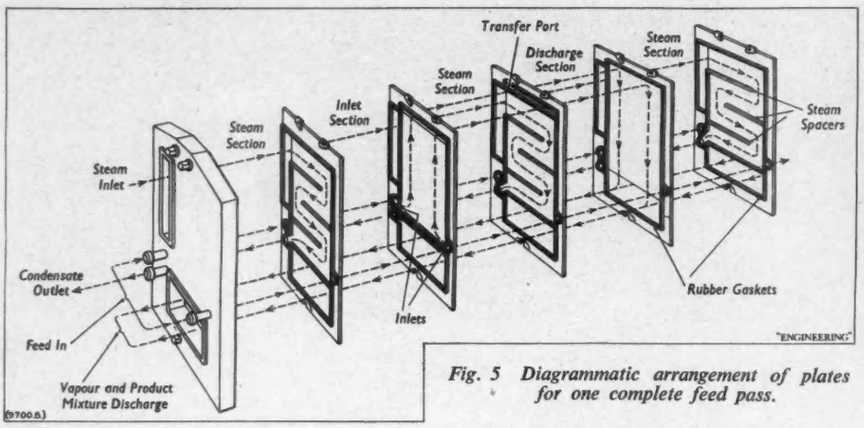

Fig. 5 Diagrammatic arrangement of plates for one complete feed pass.

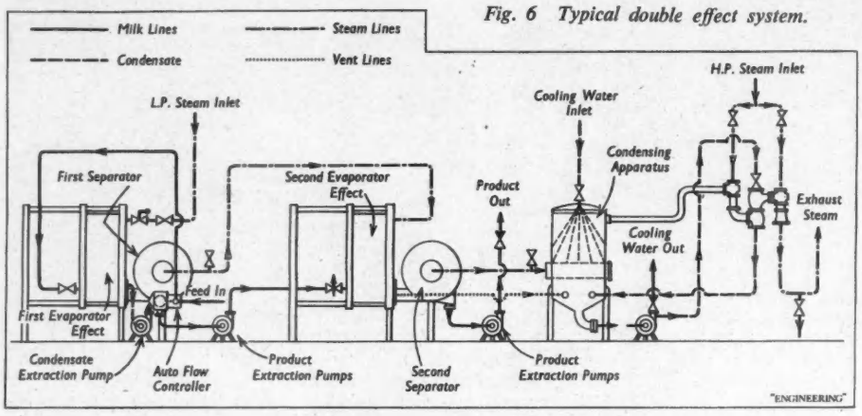

Fig. 6 Typical double effect system.

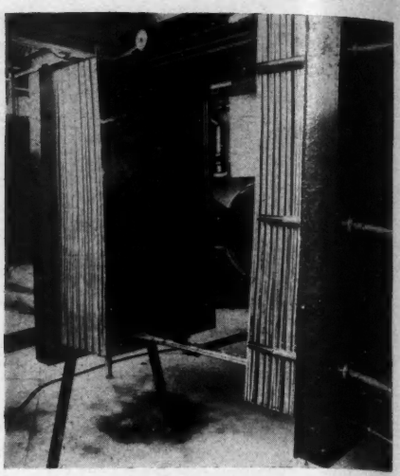

Fig. 7 Plates open, showing construction.

extraction but presents serious distribution problems. It was therefore decided to use a combination of the two whereby the process is carried out in a unit of two pairs of plates, the first pair operating on the climbing film principle where the concentration process is beginning, and the second pair on falling film which is more suitable as the product becomes viscous.

The first experimental vertical plate unit was tested successfully about 1954, but a process dealing with liquid food in large quantities does not lend itself to full scale works trials. Accordingly APV had to find a customer willing to afford them facilities to install and operate a prototype unit. Here APV's established reputation carried much weight and the company owes thanks to Messrs. Aplin and Barrett in the West Country for granting such facilities in one of their dairy factories. This unit started operation in 1956 and was rated at an evaporative capacity of 6,000 lb per hr. Not only did it successfully pass trials with a variety of milk products and apple juice, but it was also used as a demonstration machine to assist in securing the initial orders APV needed to put the plate evaporator on its feet commercially. The first order for a commercial plant was placed in August, 1958, since when well over 150 units have been ordered. After a slow start, not unexpected with an entirely new piece of equipment, the success of the plate evaporator has exceeded all expectations.

The original prototype has since done yeoman service, being moved first to Jamaica to operate on citrus juice, then to Florida and other parts of the United States.

For reasons of thermal economy evaporators of all types are usually arranged as double or triple effect machines, the vapour given up in one effect being used to heat the product in the succeeding effect. Other ways of saving steam are by the use of a thermocompressor, and also by providing feed preheating by vapours between the stages. These methods are applicable more easily and more neatly to the plate type.

The number of plates in each effect is chosen according to the temperature and viscosity conditions prevailing, in order to give the correct vapour balance throughout the system. Fig. 5 is a diagrammatic arrangement of plates for one complete feed pass. Feed entering the base of the climbing film inlet section boils on contact with the steam heated plates, rises to the top and then transfers to the falling film section where evaporation continues. A mixture of the concentrate and the vapour is drawn off under vacuum into a common manifold; this action occurs simultaneously in parallel within each unit of plates.

As with the tubular evaporator, the mixture is drawn from the manifold into a separator where the product is extracted and the vapour passes on to the next effect or to the condenser. Condensate from the steam side is also drawn from the machine and may be used for boiler feed make-up or preheating the feed of product.

The plates themselves are of standard size, approximately 2 ft 2 in wide by 4 ft deep. The gaps are maintained by rubber sealing gaskets which also separate the product from the steam. The plates have matching pips to prevent deflection due to the pressure difference across them. The separators, one for each effect, are conventional in using centrifugal action, but are novel in being mounted with the axis horizontal instead of vertical to give the same economy in headroom afforded by the plate arrangement.

The separators are made in a number of standard sizes according to the duty, and each evaporator unit is therefore built up as a combination of standard components. Fig. 6 is a diagrammatic arrangement of a typical double effect system with automatic feed control on the first effect.

The number and capacities of the effects comprising any system depend on a compromise between capital cost and running cost, bearing in mind the time/temperature relationship which suits the particular product. Maximum evaporative capacity varies with temperature of treatment, but is approximately 16,000 lb per hr at present.

The advantages in terms of installation costs afforded by the compactness and versatility of a plate evaporator, are matched by its operational advantages. Normally, only two controls are needed, one which controls the flow of concentrate from one effect to the next, and the second to control the quantity of steam entering the first effect. Stable conditions can be attained within a few minutes of starting up.

The plate evaporator is normally cleaned by circulating a detergent solution without using any labour, and here again the small internal volume is an advantage. The plates themselves can be examined very quickly by slackening off the clamping screws and opening the frame.

NEW PRODUCTS

APV are continually finding new products which are suitable for concentration in the plate evaporator and, since every kind of foodstuff possesses its own individual characteristics, the only way of finding out whether a plate evaporator is a satisfactory method of handling it, is to try it. Consequently a small pilot plant is kept operating in their works at Crawley for this purpose. The total number of different materials that have been successfully dealt with now forms an impressive list; it includes skim and whole milk, buttermilk, apple, orange, blackcurrant and pineapple juices, malt extract, gelatine, sucrose, corn sheep liquor and meat extract.

Plants in operation are the best salesmen in the process industry, and business is building up steadily. Nearly two-thirds of the plate evaporators being sold are for export, and APV have associate companies in Australia, Canada, India, USA, Brazil, France, Belgium, Italy and Ireland.

Some fruits are only available for picking during a comparatively short season, and concentration is becoming more widely adopted all the time as a method of storage to spread the availability of the juice throughout the year.

Continuous production has already largely displaced batch production in the food industry and the plate evaporator is making a big contribution to the furtherance of this trend. Despite the emphasis on food products the plate evaporator principle has been proved in other fields, and its use may be expected to extend further in other process industries.

New Towing Carriage for Shipyard Laboratory

In order to keep research equipment in step with the modernisation of their shipyard facilities, a new towing carriage has been installed in the experimental tank at John Brown's Clydebank Yard. It is of light alloy material, to give maximum strength at low weight.

Now in operation, the new carriage incorporates modern ideas in drive, control and instrumentation. Power is supplied by a Ward-Leonard loop system, connecting a shore-based motor generator in series with the carriage's four motors. The speed control is achieved by regulating the voltage of the generator, the excitation of which is by means of a magnetic amplifier. With this arrangement, the operator can pre-set the main speed control potentiometer at any desired final speed; automatic acceleration being obtained simply by closing the main contactor. An overhead cut-off stops the carriage automatically at the end of the run. Push button controls are conveniently arranged at the operator's position on the carriage.

Current is supplied through a grid of eleven overhead wires, the pick-up being through miniature trolley boom collectors. This overhead grid supplies 240 volts ac, 220 volts dc and 12 volts dc, to selected points on the carriage.

The braking system is of the Dunlop disc-brake type, fitted to each driving wheel unit and operated from one master cylinder solenoid. Separate manual units are fitted on the rear wheel units for use in an emergency.

The main attraction of the new carriage is clean design and the large amount of space for operation and observation. It is so arranged that one half of the available space houses the permanent gear for normal resistance experiments and includes a new dynamometer and recording head. The other half encloses a large open space, to be utilised for auxiliary trucks and other equipment used in special research programmes.

The experimental tank at John Brown's Clydebank Shipyard, installed in 1903, was among the first privately owned model basins to be built. It was designed on the basis of the Froude tank at Haslar. Many improvements have been made since that time, however, including the installation of a wave-making machine and the design and construction of special equipment for the making of model propellers.

The making and testing of model propellers have been carried out at Clydebank since 1909. These propellers were of suitable size for the execution of experiments in association with ship models of 200 in length. Some years ago, a special unit was developed for the testing of 24 in diameter model propellers in open water for the derivation of open efficiencies.

In recent times, experimental investigations carried out in association with the British Shipbuilding Research Association have included the comparison of various stern arrangements in single-screw vessels, the investigation of the effect of bulbous bow on resistance, the carrying out of resistance tests on models of large block coefficients and the testing of launching greases.

One of the main attractions of the new John Brown towing carriage is its large area for observation.

Hardness Testing for Engine Temperatures

A simple method for measuring the operating temperatures of engine parts, such as valves and pistons, has been developed by research engineers of Shell Research Limited, Thornton, Cheshire.

Usual temperature measuring devices cannot easily be attached to these rapidly-moving parts inside the engine block, but the Thornton Laboratories have developed a technique whereby each component literally registers the maximum temperature to which it is exposed. When the engine is taken apart, this temperature is deciphered in the laboratory.

High temperatures can build up locally on pistons, rings, bearings, gears and valves, and, if they become too high, premature failure can result. As a result of this new technique engineers can now pin point these hot spots and then take steps to overcome them.

The Shell technique, known as the " hardness relaxation " method, depends on the fact that when certain alloys are heated and then cooled, their original hardness is changed. The extent of the change depends on the maximum temperature reached. This fact in itself is not new, but it has now been applied to taking the temperature of moving parts in cars and in large engines used in ships and trains.

Usually it is only necessary to compare the original hardness of an engine component with its hardness after running to determine with accuracy the maximum temperature reached in the range of 100° C to 1,000° C. When the metal of a particular engine component is not suitable for recording accurately the maximum temperature reached, small inserts of any suitable alloy can be placed in the part under study. The change in hardness of the insert will then give a measurement of the maximum temperature reached. A wide range of alloy inserts has now been developed for this purpose.

An interesting application of this technique helped solve the problem of a car owner in the Australian bush. The car was a make renowned for its performance and no one could discover why it would go for a few miles and then stop dead.

Shell laboratories were told of the symptoms and the engineers there were fairly sure that the sparking plugs were overheating. To check their diagnosis, they sent out a set of specially-prepared plugs. These were run in the car and then sent back to the laboratory 12,000 miles away. Examination of the change in hardness of the plugs showed that temperatures in the order of 1,000° C were being reached. It was a simple matter to adjust the timing to make the engine run cooler.

Techniques such as these can remove much of the guesswork from the diagnosis of failures and they could undoubtedly be used to bring about a quicker realisation of what to avoid in new design.

Rapid Frequency Change for Short-Wave Sets

Two new 100 kW short-wave transmitters have been installed at the BBC's external services transmitting station at Rampisham, Dorset. The first of these was brought into operation on 5 March and the second will be in use early in April.

This is part of a long-term plan for the modernisation and re-equipment of BBC short-wave transmitting stations, where most of the installations have been in service since the early days of the Second World War. The four original transmitters at Rampisham have been in continuous use since 1940. Their total programme output averages about 78 hours per day.

The design of the new transmitters departs from earlier practice in that vapour cooling is used for the valves in the final radio frequency amplifier and modulator stages. In this system, the heat from the valves is transferred to water jackets surrounding them where it produces steam; this is then carried by convection to an air-cooled condenser which reconverts it to water for return by gravity feed to the water jackets.

Special attention has been given to the problem of providing rapid change of operating frequency. This is a very important factor in short-wave broadcasting since carrier frequencies must be changed often in order to maintain adequate service under rapidly changing propagation conditions. With this new equipment a frequency change can be carried out in a few seconds by a simple switching operation which has been made possible by the provision of two radio frequency amplifiers for each transmitter. These amplifiers, contained in separate cabinets, are located on either side of a common modulator which can be switched to either. Thus, while one radio frequency amplifier is in use, the second can be set up for another frequency; which means that the scheduled frequency change can be made simply and almost instantly.

In addition to changing the transmitter frequencies at scheduled intervals, it is also necessary to switch the transmitter to different aerial arrays which are designed to radiate in a particular waveband and on a certain bearing, thus ensuring a maximum signal in the target area. For this purpose, BBC engineers have developed a new form of electro-pneumatic switch which is remotely controlled from inside the station and enables the output of the transmitter to be connected to a selected aerial feeder. The use of this system, which has already been tested under operational conditions at the BBC's external services transmitting station at Skelton, Cumberland, will assist the rapid selection of the correct aerial array for each particular schedule.

The new transmitters at Rampisham have been manufactured to BBC specification by Marconi's Wireless Telegraph Company Limited and the vapour valves have been made by the English Electric Valve Company Limited.

A University's Research for Industry

Current research on hydromechanic lubrication, plastic working of metals, and experimental stress analysis, conducted in a university has a value that can be immediately exploited in industry.

SINCE its introduction by the late Professor H. W. Swift, on his appointment to the chair of Engineering in 1936, one of the main research subjects has been hydrodynamic lubrication. Aspects of the subject which have been studied have included the operation of tilting and stepped thrust pad bearings, dynamic loading of journal bearings, and the lubrication of spur gears and of discs in rolling and sliding contact.

Hydrodynamic Lubrication

In recent years the principal interest has centred on the lubrication of fixed thrust pads, and to a large extent this has stemmed from the work reported by Fogg to the Institution of Mechanical Engineers in 1945 concerning the "film lubrication of parallel thrust surfaces." In terms of simple hydrodynamic theory it was well known that a parallel film could not generate fluid pressures capable of supporting a load. Fogg's findings that plane pads exhibited load-carrying abilities comparable with those of tilting pads, albeit with somewhat higher friction, was of considerable interest. Fogg offered a tentative explanation of this generation of pressure, which had undoubtedly been present, in terms of thermal expansion of the lubricant as it passed under the pad. The discussion stimulated by Fogg's report shows that this mechanism, usually referred to as the "thermal wedge action" or "Fogg effect," was not generally accepted as convincing, primarily due to the effects of side-leakage. Swift pointed out that a cambering of the pad due to differential thermal expansion need only be small in order to permit the generation of pressure in the resulting convergent part of the film in the same way as in a tilting pad. In this case, Swift suggested, it would be better to provide a camber on the pad surface rather than to chance achieving the same effect by thermal expansion.

Following upon this the hydrodynamical lubrication of wave-profiled thrust pads has been investigated[1]. It has been concluded that thrust pads having a single sinusoidal profile, with an amplitude of the same order of magnitude as the desired operating film thickness, have performance comparable with that of tilting pad bearings. The principal complication of fixed thrust pads lies in the provision of the profile on the pad surface. A bearing has been developed which overcomes this difficulty by inducing a profile by elastically deforming a ring of otherwise plane thrust pads. Tests on the bearings have proved highly satisfactory and suggest that such a bearing might in certain cases provide a simple alternative to the tilting pad arrangement.

With the object of determining the principal mechanism which accounts for the operation of a "parallel-film" pad, the pressure and temperature distribution and operating characteristics of a bearing comprising such pads have been investigated. An annular bearing, approximately 8·0 in outside dia. × 3·0 in internal dia. × 1·0 in thick, was machined to present to a plane mating component three equally spaced 60° sector-shaped pads. It was provided with pressure tappings for recording film pressures and temperature probes to permit the measurement of temperatures within the bearing metal. The analysis of experimental results obtained is not yet complete but it is clear that the film very quickly assumes a convergent-divergent shape due to thermal expansion of the bearing pads. Estimated pressure distributions based on the true film shape compare favourably with those determined experimentally. Pressures calculated on the basis of the thermal wedge theory are very much too small to account for the load carried. A particular case is illustrated in Fig. 1. The film thickness was determined by air-gauging and has been corrected for thermal expansion of the bearing. The errors inherent in the specification of a minimum film thickness of the order of magnitude involved are being further investigated. While the value of minimum film thickness quoted may be in error to extent of 20 per cent, the conclusion that *it is thermal expansion of the bearing pad* which primarily accounts for the operation and that thermal wedge-action in this instance is a minor effect is clear from a comparison of the pressure distributions shown.

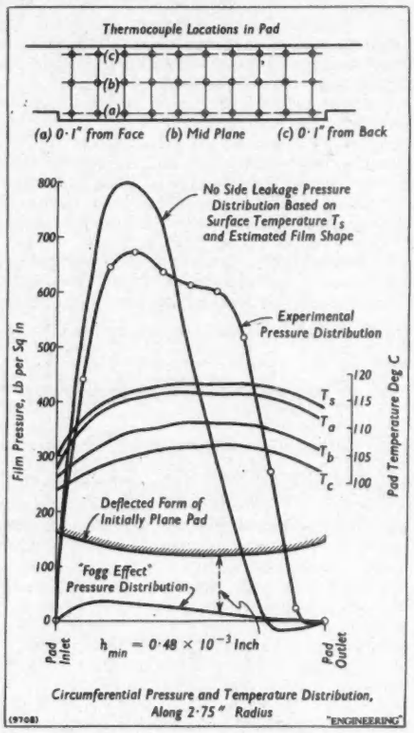

Fig. 1 Characteristics of plane thrust pads cambered by differential thermal expansion. Sliding speeds: 605 in per sec. Load: 1,870 lb per pad. Pad dimensions: 60° sector pad, inner radius 1·55 in, outer radius 3·95 in, thickness 1·06 in. Pad material: phosphor-bronze.

Data collected in the course of recent experimental work is currently being examined with the object of a fuller understanding of the stabilising influence of heat transfer between the lubricant and the bearing parts.

Plastic Working of Metals

Following the invitation given in 1936 by Dr. C. G. Williams, then of the Motor Industry Research Association, to examine the mechanics of deep drawing and the assessment of drawability of sheet steel, the late Professor H. W. Swift established the department with an international reputation as a centre of research into the plastic forming of metals. The Swift Test for drawability was so named in recognition of his personal contribution.

Research into the fundamentals of drawing and the correlation of tests and practice has continued and members of the department are taking a leading part in the activities of the International and British Deep-Drawing Research Groups. A machine designed in the department for routine cup-testing is in commercial production and the prototype has been used continuously for development of various tests and the assessment of theoretical predictions. The "rough punch technique"[2] resulted from study of the deformation over the nose of the punch. Currently a study and development of the hydroform technique is being made with international and industrial cooperation.

Detailed elements of presswork practice, such as ironing, sinking, bending (with and without tension), sheet-drawing and stretch-forming are being studied separately. Recent work on the ironing and sinking of tubes has been supported by the Department of Scientific and Industrial Research and Tube Investments Limited.

Among the theoretical developments in these projects has been the "force field technique"[3] for the calculation of upper bound loads in deformation problems with boundary friction. Within the operating range this theory gives solutions within a few per cent of the exact solutions obtained using slip line fields. Stress solutions and analytical stress and strain solutions have also been established for various drawing processes. The study on sinking in particular has shown the influence of the D/t ratio, friction and work-hardening on loads and thickness changes.

The calculations from these theories are currently being compared with experimental measurements obtained on a 30 ton, 80 ft per min drawbench designed in the department and installed in the Metal Forming Laboratory. The bench incorporates a novel floating piston which alleviates alignment and surface finish problems in the bore of the single long actuating cylinder. Certain features have served as a prototype to a new form of bench which is being developed.

The primary drive to the hydraulic pump of this bench is common with the main drive to a 10 in × 10 in, 2-high cold rolling mill which is instrumented to measure loads and torques and front and back tensions. The mill and its associated equipment has been used to examine the influence of roll-finish on the rolling and on the properties of temper-rolled mild steel strip. It is also made available to outside bodies for routine and other tests. The problem of continuously and accurately indicating temper rolling reductions may be overcome by a system of instrumentation currently being developed with the cooperation of Smith's Industrial Instruments Limited and the Steel Company of Wales.

From an examination of the effect of a mill-frame on gauge-attenuation, the prestressing of the frame and the control of the mill through wedges between the rolls has been suggested in

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a design study and is being implemented in industry.[4] A similar system may be used to give a degree of control of roll-shape. Algebraic, slipline field and limit theories are being employed to examine the loads and deformations in rolling with a low ratio of roll diameter to material thickness and the results are being applied to the planetary mill and also combined with an investigation of the problem of heat transfer in rolling to estimate the optimum roll-sizes for high speed cold reducing mills.[5]

Theoretical and experimental work on extrusion is following earlier experience under a DSIR contract and recent developments of axi-symmetrical deformation theories. The hypothesis of adiabatic deformation was formulated and supported by experiments under the impact of a drop hammer. An examination has also been made of the energy balance of the impact operation and the subsequent motion of the hammer. Other experiments have since been performed on industrial hammers and recommendations made for the reduction of ground shock and anvil bounce. Coining, cold forging and compression of cylinders have also received some attention using the hammer, a high speed crank press and a 30 ton Plastometer.

The reeling of bars and the roller levelling of sheet are among other projects which have received the close cooperation of the steel industry and of the British Iron and Steel Research Association. These activities form the background to current work on the processing of spring steel wire and the suppression of the yield point in rimming steels.

Difficulty in the stretchforming of exotic materials for aircraft and missile production was shown to be explained partially by high friction over the former and by the gripping of the ends of the sheet. In the ice lubrication technique[6] which was devised and developed with the support and cooperation of the Ministry of Supply and A. V. Roe Limited, the surface of the former is sheathed by a thin coating of ice and fluid lubrication on the ice sheet interface is attained when desired by inducing the solid-liquid phase-change. Values of μ of 0·01 are readily obtained and an established film may be used many times. Further development of the principle is permitting its application to other processes and particularly to warm working.

Another problem encountered in aircraft production and in general industry, the spring-back in cold roll-formed sections, has also received some theoretical and experimental study and a mill has been constructed in which forming rolls from 3 in to 12 in may be accommodated.

Among the studies of factors complementary to the projects outlined are lubrication and surface finish, residual stress and its effect on static and fatigue properties, instability under plane stress systems and the determination of friction in tube-drawing. Each major investigation has been conducted with the close cooperation of industrial or research bodies. Results have been largely reported by means of publication, reports, colloquia and conferences.

Experimental Stress Analysis

The third group of researches into methods of experimental stress analysis were initiated by Professor J. P. Duncan upon his appointment in 1957.

At that time, the first nuclear power stations were being designed and higher steam temperatures and pressures were being adopted for new power stations of conventional type. These developments jointly accounted for increased interest in pressure vessels and heat exchangers and necessitated and gave impetus to more rational methods of stress analysis than had previously sufficed.

The occurrence, or adoption, of perforated plate in diagrids, tube plates, boiler drums, etc., and indeed the occasional use of perforated plate in other contexts, such as the spinneret used to produce artificial fibres, inspired a systematic study of the general properties of laterally loaded plates drilled extensively in a closely pitched regular array.

Plates which have been continuously drilled in such regular arrays exhibit much greater flexibility than the native material from which they are produced. They have been shown to exhibit an equivalent Young's modulus and Poisson's ratio different from the true values of the native material. This had long been recognised implicitly in the conventional methods for designing tube plates for heat exchangers but Gardner, Horvay and Malkin first discussed and demonstrated this concept in a logical and rational manner.

In 1952 Professor Duncan reviewed the then current state of knowledge of the subject and showed how "equivalent elastic constants" could be determined accurately by means of the technique of *interferometry*.

In 1869, A. Cornu first showed how the contours of an anticlastic surface, developed on bar subjected to pure bending, could be revealed as a system of interference fringes produced between the bar and a glass optical flat in close proximity to it. At Sheffield this old idea has been pursued as a means of revealing the anti-

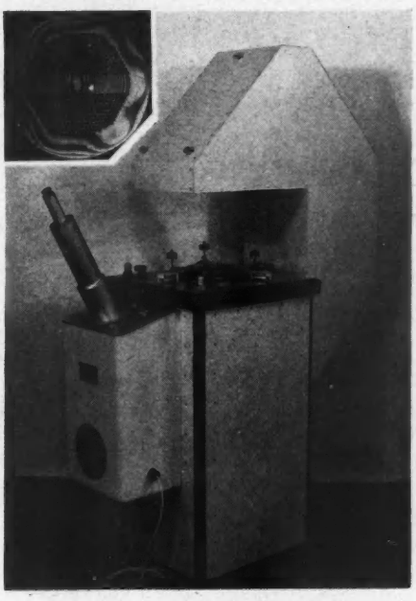

Fig. 2 A Fizeau interferometer with 12 in for two-sided viewing. The inset is an interferogram of a model two-pass encastre tube-plate. The lobular character of the peripheral orders is caused by clamping studs.

clastic surface developed by the pure bending of perforated bars. From a single interferogram, an equivalent Young's modulus and equivalent Poisson's ratio can be deduced. Specimens for these tests are produced by means of flat lapping, initially by hand lapping but now by means of flat lapping machines. This preparation has now been developed into a rapid and reproducible routine. The surface contours, as represented by interference orders, are observed by eye or photographed with the aid of interferometers of which four types have been employed.

One such instrument, incorporating features gained through experience with earlier models, is illustrated in the accompanying photograph. In this latest version, interference fringes are produced by means of Fizeau's method in which there is no contact between the glass reference plane and the surface being observed. The instrument and the technique of its use have been fully described by Professor Duncan.[7, 8]

In many perforated plates employed in practice the pattern of drilling is not continuous. In these instances, if the properties of continuously drilled plate are known, methods of analyses of non-continuously drilled plate are sometimes possible. Such methods have been developed but occasionally even these are intractable. In such instances, the topography of such a plate can again be revealed by means of macroscopic interferometry in which interference orders may extend over the whole area of plates of 8 in diameter and more, which have been flexed by lateral loading.

The instrument illustrated in the accompanying photograph has a 12 in diameter field and is capable of revealing the topography of any laterally loaded plate of up to 12 in diameter. It is also capable of revealing the topography of both sides of the plate at any one instant and under any single loading condition.

These developments in interferometry as a means of analysing the flexure of plates have led logically to the development of other methods for revealing, by means of one photograph, the slopes which exist in such plates. A well known existing method for doing this is the Moiré, and there are others. Many of these have been developed in connection with the soap film analogy of torsion. A study of all these methods suggested the development of the method known as the Salet-Ikeda method and led to its successful development of the method for the study of very small slopes in elastic plates. These developments have been described in a forthcoming paper.[9]

It is proposed to develop from the Salet-Ikeda technique a method of revealing curvatures in flexed elastic plates by means of contours, thus completing a triology of methods for recording deflections, slopes and curvatures at single observations.

A point-by-point method of recording curvature in plates has already been developed, in which the spherometer invented by Professor Martinelli of Padua to measure the curvatures of soap films, has been adapted to measure the very small curvatures which exist in plates. This development continues.

In parallel with the above investigations, certain experimental studies of pressure vessels have been made. One such series has been concerned with the development of lobed pressure vessels. Another with the design of conically stayed pressure vessels of the dished-end type in which the flat portion of the dished-end is braced to the flange of the dished-end by means of a simple frustum of a cone. Yet a third series of studies have examined the restraint offered to a flat circular plate by bolted flanges of varying stiffness with and without gaskets. These studies were suggested by the writings of Professor Yi-Yuan-Yu and some improvements in his analyses have suggested themselves. Current pressure vessel studies are directed at the further refinement of rational methods.[10]

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Using Space

THE house builder has a constant battle—to build a house big enough for a family and yet small enough to keep the price reasonable. This tends to result in small rooms, combatted in part by using the open plan, but still putting a premium on equipment that requires little floor space. As more and more equipment is being installed in each home, this premium is becoming greater, reaching its peak probably in the one bedroom flatlets called for by the Minister of Housing for elderly people, and in the ever popular "bed-sitter."

Manufacturers have met the demand in two opposite ways; by combining two or more appliances into one unit or by dividing appliances into two parts that can be mounted separately—this condition applying particularly to the cooker. Most cooker manufacturers now offer oven units separate from hobs and often situated some way apart.

An example of the former trend is the Compacta unit which was described on 26 August, 1960 (p. 296). This is a combined cooker (with oven and hob), sink and refrigerator, the latter being under the sink and alongside the cooker. Floor space required is only 4 ft long by 2 ft deep yet the cooker has four rings and a full size oven and the refrigerator has a capacity of over 5 cu. ft, with a 25 lb freezer. This unit comes from the Continent where the tendency towards combined units is far more marked than in this country.

A more recent British example is the Cannonlux unit illustrated. This has a refrigerator for the base with a four ring hob mounted on it; above is a combined oven and grill unit. The design is the result of cooperation between Cannon (GA) Limited, who are responsible for the cooking section, and Electrolux Limited, who make the refrigerator. Heating—and cooling—is by gas and the combined unit is designed to fit flush against the wall to save space. The floor area required is 21 in by 25 in, and the working height of the hob is 34 in.

The refrigerator is the Electrolux model "Sixteen" which has a capacity of 1½ cu. ft with 3½ sq. ft of shelf area. It has two removable door shelves for bottles and eggs, and a frozen food packet can be stored in the ice compartment.

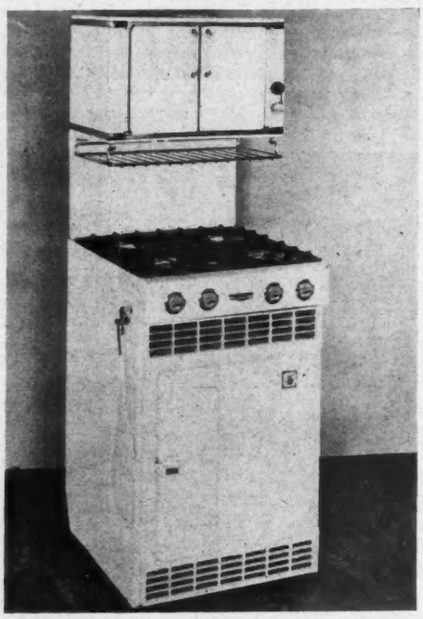
The four hob rings give accommodation for four 10 in saucepans and are equipped with automatic lighting. The rear pair are designed for simmering. Complete sealing below the hotplate prevents seepage resulting from spills. Several alternative arrangements are possible: the oven-grill can be replaced by the Foldaway high level grill which will fold up when not in use, or a separate oven unit can be supplied for fixing alongside. A plate rack is also available in the place of the grill.

The second illustration shows how the other method works. In this case the hob and oven units are made by Creda. The hob with its four rings is mounted as a corner unit in the layout, and the oven is at the right, fitting against the range of cupboards. The units will fit in with most makes of kitchen equipment; that in the illustration is by Kandya. With this arrangement the oven comes at working height without obstructing the working area.

The hob is available in two forms either with four rings or as two units each of two rings. The controls are mounted on the panel below. The timing control unit for the oven is shown mounted separately and centrally over the working top where it is easy to reach and to see. It includes a timer and a five hour "alarm" ringer to give warning when the meal is ready, and two 13A sockets for using portable appliances such as kettles, mixers and grinders. The timer control also operates on these outlets if required.

The oven is the Mercury model with the grill mounted in the top. A Rosta-Spit unit can be used inside. Above the oven is the warming compartment with two shelves for plates and dishes, and the oven is protected from draughts by a glass inner door. Controls for oven, grill, and spit are on the top panel over the door and there are pilot lights on the same panel showing which is in use.

In company with other firms, Creda also produce a refrigerator for building into kitchen layouts, the advantages being as for ovens, namely, compactness and, by having shelves at working height, the avoidance of stooping.



The Cannonlux unit above saves space by having a refrigerator in the base surmounted by a hob and an oven-grill. Split units, as on the left, show another way of using space to the best advantage.

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